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SPECIAL ADVANCED STUDIES FOR POLLUTION PREVENTION

Delivery Order 0058: "The Monitor" – Fall 1999

Science Applications International Corporation
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APRIL 2001

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STINFO FINAL REPORT

MATERIALS AND MANUFACTURING DIRECTORATE
AIR FORCE RESEARCH LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-7750

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THIS TECHNICAL REPORT IS APPROVED FOR PUBLICATION.

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Support the Warfighter

In this issue...

The MONITOR is a quarterly publication of the Headquarters Air Force Materiel Command (AFMC) Pollution Prevention Integrated Product Team (P2IPT) dedicated to integrating environment, safety, and health related issues across the entire life cycle of Air Force Weapon Systems. AFMC does not endorse the products featured in this magazine. The views and opinions expressed in this publication are not necessarily those of AFMC. All inquiries or submissions to the MONITOR may be addressed to the Program Manager, Mr. Cliff Turner.

Cliff Turner

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Feature Story

AIR COMBAT COMMAND (ACC) HOSTS THE 13TH WEAPON SYSTEM POLLUTION PREVENTION CENTER WORKING GROUP CONFERENCE

In August 1999, Air Combat Command (ACC) hosted the 13th Air Force Materiel Command (AFMC) Weapon System Pollution Prevention Center Working Group (CWG) conference in Hampton, Virginia. Invitees to the conference included over 50 participants from various organizations. According to Ms. Debbie Meredith, the AFMC CWG Chair, the goal of this three day conference was to "foster a dialogue and create opportunities for partnerships between the warfighter and maintainer communities and the Air Force/DoD organizations that support their pollution prevention activities."

Mr. Bruce Stephens, ACC/LG-EM, along with ESC and HQ AFMC/LG-EV, organized the three day event to include presentations from seven Major Commands (MAJCOMs), eight different Air Force weapon system and presentations from Air Force/DoD organizations that provide pollution prevention support to these communities. The presentations were structured to facilitate working group discussion, cross-feed, and generate action items, as necessary.

Air Force Major Commands (MAJCOMs) presentations were given by the following individuals:

- **SMSgt Greg Stonelake, ACC/XRSS**, provided a briefing regarding ACC's current environmental and health issues (see related article on page 4).
- **SMSgt Kelly McCarville, HQ AMC/LGBE,** presented, on behalf of Chief Robert McDonald, a brief history of AMC's P2 Program, including the current AMC field level P2 initiatives (see related article on page 6).
- **CMSgt James Long, HQ AETC/LG-EM,** addressed the group regarding an ESOH Technology Needs Planning, Programming, and Budgeting Management Guide authored by AETC (see related article on AETC on page 7).
- **Mr. Dan Rodriguez, HQ AFSPC/CEVV,** discussed the unique weapon system pollution prevention challenges and opportunities facing the warfighter in the space community (see related article on page 8).
- **MSgt Nancy Jamieson, HQ AFSOC/LGMW,** discussed the AFSOC mission, P2 success stories, and current P2 issues (see related article on page 26).
- **Mr. Robert Leong, HQ PACAF/CEVQ,** discussed the PACAF Weapon System P2 Program, past P2 activities, and the PACAF Compliance Site status (see related article on page 9).
- **Maj. Lyn Gemperle, HQ AFMC/CEVV,** described the HQ AFMC business process and how AFMC can assist field units with P2 initiatives (see related article on AFMC on page 9).

The feedback from the participants to this event was favorable and the continued facilitation of such dialogue encouraged.

This issue of the MONITOR discusses the key issues, concerns, and successes of the Air Force warfighter and the maintainer communities, as presented at the 13th Weapon System Center Working Group Conference. It also provides information about the current pollution prevention activities of some of the key organizations that support these two communities.◆

CORROSION PROTECTION AND ENVIRONMENTAL LOGISTICS AT AIR COMBAT COMMAND (ACC)

Air Combat Command (ACC) is headquartered at Langley AFB in Virginia. ACC operates fighters, bombers, reconnaissance, battle management, rescue and theater airlift aircraft, as well as command, control, communications and intelligence systems. Figure 1 provides a listing of the flight chiefs at ACC's operational bases.

One of the biggest issues facing the maintainer community in all commands, including ACC, is related to corrosion control. According to a study conducted by the Air Force Corrosion Program (see related article on page 11), the total annual cost of direct corrosion maintenance to the Air Force is approximately $790 million.

HQ ACC defines the Command Corrosion Prevention and Control Program through ACCI 21-105. Elements of this guidance includes the following:

- Defines the need for local Maintenance Operating Instructions (MOI)
- Defines the roles and responsibilities of various maintenance activities outside structural maintenance.
- Defines the command's requirements for aircraft paint and washing
- Established and defines local corrosion training requirements

Field Unit	Flight Chief	Phone (DSN)
Avon Park Range	Paul F. Ebersbach	968-7119
Barksdale AFB	Sue Landry	781-4629
Beale AFB	Greg Miller	368-2641
Cannon AFB	Daniel A. Barnett	681-6022
Davis-Monthan AFB	John Thompson	228-5372
Dyess AFB	Teresa Clouse	461-5619
Ellsworth AFB	Mark Wheeler	675-2680
Holloman AFB	John R. Poland	867-3931
Howard AFB	Maj Richard Anaya	(313) 284-5165
Lajes Field	Russ Shannon	535-6323
Langley AFB	Ken Walker	574-3906
Minot AFB	Thomas Atkinson	453-4871
Moody AFB	Vacant	460-3069
Mountain Home AFB	Gary Burton	728-6351
Nellis AFB	Eloisa Hopper	682-4123
Offutt AFB	Edward Lueninghoener	271-4087
Seymour Johnson AFB	Donald R. Abrams	722-5168

Figure 1. Field Unit Flight Chiefs at ACC

Unit level participation in Corrosion Prevention Advisory Boards (CPABs) ensures proper correction of identified problems through changes in design, technical instructions, and/or changes to materials and processes used. MAJCOM Corrosion Managers, weapon system program managers and the AF Corrosion Prevention and Control Office work directly with field units to resolve aircraft corrosion and coating related issues. This forum also provides units an opportunity to share process improvements and best practices.

A field level logistics issue that arises from environmental concerns is the need to develop a deployable wash system with effluent treatment for use at remote deployment locations. For example, when the B-52 is deployed to Diego Garcia, a severely corrosive environment, the aircraft cannot be washed without a containment and water treatment system. Environmental regulations restrict the discharge of the generated wastewater without proper treatment/control. A deployable wash system is the most feasible method to comply with this requirement in order to reduce the logistics footprint, but a reliable system that meets user needs is not available at this time. Currently this logistics concern is being investigated through a Defense Logistics Agency funded study.

A second issue related to aircraft washing is driven by TO-1-1-691 and requires daily clean water rinse for aircraft under certain flying conditions to prevent corrosion. Environmental regulations require capture and treatment of the effluent from the daily clean water rinses. Installation of a system to meet this requirement can cost more than $500,000/unit. Corrosion study data collected during PDM cycles on the F-15 at Langley AFB indicate that this requirement may be too stringent for corrosion protection. Systems engineers at AFMC should revisit the TO requirement and verify its need. Complying with the TO requirement is costly for the field units due to environmental regulatory constraints.

For further information regarding HQ ACC's Environmental Logistics Program, please contact SMSgt Greg Stonelake at HQ ACC/XRSS at DSN 574-1731. ◆

'SMOOTH TRANSITION FROM TEST TO BEDDOWN' F-22 ENVIRONMENTAL & HEALTH WORKING GROUP (E&HWG) LESSONS LEARNED

Perry Beaver

The last two decades have seen an unprecedented proliferation in the number of laws aimed at the protection of the environment and the protection of workers' health. These laws have had an enormous impact on the cost of producing and maintaining modern weapon systems. For DoD, lack of early Environmental, Safety and Health (ESH) involvement in the acquisition process has resulted in the fielding of weapon systems that are difficult and expensive to produce and maintain. Additionally these weapon systems are more manpower intensive and have a larger deployment footprint. The bottom line is that failure to anticipate and mitigate occupational and environmental risks can severely impact the overall life cycle costs and schedule for producing, fielding and maintaining a weapon system.

The F-22 Environmental & Health Working Group (E&HWG) has taken a business approach to Environmental and Occupational Health (EOH) integration. The F-22 E&HWG is comprised of ESH representatives from all the Air Force organizations involved in the life cycle of the weapon system, including the major F-22 contractors. The E&HWG includes representatives from Air Combat Command, the Air Education Training Command (AETC), the Advanced Tactical Fighter Program, the Combined Test Force, the Lockheed Martin prime contractor, the Boeing Corporation (sub-contractor), and Pratt & Whitney**.** A key element in the effectiveness of the E&HWG is having representation from the F-22 Combined Test Force (CTF). The F-22 CTF is an integrated team composed of government and contractor personnel responsible for the test and evaluation of the F-22 weapon system. This is where the "rubber meets the road."

By taking a proactive approach to integrate EOH into all phases of the acquisition and flight testing, the F-22 E&HWG has 1) reduced the life-cycle costs through pollution prevention; 2) decreased the occupational/environmental footprint; and 3) facilitated flight test. Below are some of the lessons learned from the F-22's initiatives to integrate EOH into flight-testing.

Lessons Learned

One of the primary methods for ensuring early and continuous ESH involvement has been establishing an ESH Bioenvironmental Engineer (BEE) position within the 412th Flight Test Wing at Edwards AFB.

Major Matt Birch, a Bioenvironmental Engineer assigned to the 412th Test Wing, is co-located to the F-22 CTF at Edwards AFB, where he serves as the F-22 ESH Acquisition Risk Manager. This position was created to support the F-22 SPO/EWG's involvement/interface during development and flight-testing and to establish a model for other acquisition programs. "My job is to work proactively with the SPO, SMO and contractors to develop and acquire a weapon system with the smallest occupational health and environmental burden possible within program operational requirements, budget and schedule," said Major Birch. Today, addressing ESH issues during F-22 development and flight testing are viewed by the CTF as a mission enhancing rather than detracting activity. The F-22 ESH Acquisition Risk Manager provides the critical interface for this shift from "inspector to stakeholder" (see Figure 2 on page 6). As a team member, Major Birch has assisted the CTF in several areas, including the HAZMAT Pharmacy, ESH integration for logistics testing, and health evaluations/PPE. Additional support has been provided for environmental permitting and beddown issues, and in assisting the F-22 SPO on MILCON designs for future operational bases.

This proactive, up front ESH integration has had significant benefits to the war fighter. Early participation has resulted in reduced occupational physical requirement, smaller waste streams, reduced requirements for PPE and Engineering controls, and less hazardous material use. The impact for the beddown phase is significant. By transferring data gained during flight testing to operational bases, base staffs do not have to replicate work that has already been done. They can plan for any additional workload, ensure that all required permitting is accomplished, and be spared expensive surprises.

Conclusion

Incorporating ESH into weapon system acquisition, beddown, and flight-testing has significant advantages. These include improved maintainability, assisting in faster sortie generation, and improved mobility, resulting in a smaller de-

ployment footprint. ESH integration directly supports Air Force core competencies of rapid global mobility and agile combat support, and enhances flight-testing and beddown. Finally, incorporating ESH into Weapon System Acquisition and flight test radically reduces weapon system life cycle costs, freeing assets for other critical Air Force missions.

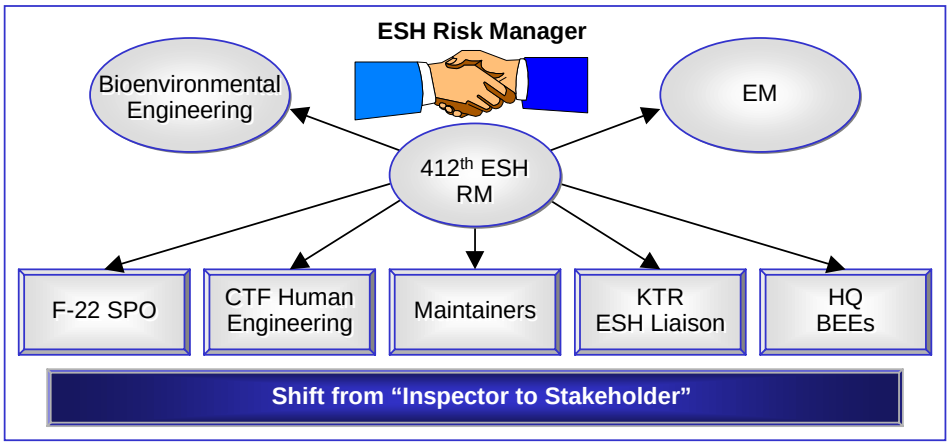


Figure 2. CTF Interface

For further information about these initiatives, please contact Mr. Perry Beaver at DSN 785-1422 ext. 2230 or Major Matt Birch at DSN 527-5780.◆

AIR MOBILITY COMMAND (AMC)

Air Mobility Command's mission is to provide airlift, air refueling, special air mission, and aeromedical evacuation for U.S. Forces. AMC also supplies forces to theater commands to support wartime tasking. As the Air Force component of the United States Transportation Command, AMC is the single manager for air mobility.

SMSgt Kelly McCarville (HQ AMC/LGBE) briefed for Chief Robert McDonald at the 13th Center Working Group (CWG) and summarized some of the field level initiatives that have been implemented within the command. The focus of AMC's P2 Program is to promote innovations that make sense by weaving pollution prevention into daily operations, peacetime, and contingencies. Some of the field level initiatives that have generated from this philosophy are summarized below.

Conversion of Waterfall Paint Booth to Dry Filter: This initiative has been implemented at both Charleston and Fairchild AFBs. Charleston AFB reduced its annual disposal costs from $18,000 to $760 annually. Fairchild AFB reduced costs from $3,500 to $160 annually. The process also eliminated liability for leakage/spillage of thousands of gallons of contaminated water. (POC: Dale Cook, Charleston AFB, DSN 673-2284; MSgt Timothy Toth, Fairchild AFB, DSN 657-5995).

Bioremediating Parts Washers: McChord AFB replaced 12 PD-680 parts washers and Fairchild AFB replaced 5 PD-680 parts washers with water-based solutions that use microbes to break down oil, grease and fuel. The microbes thrive on "eating" petroleum products and reduce the volume of the waste stream by 50 percent. (POC: MSgt Michael Chupa, McChord AFB, DSN 657-5995; MSgt Timothy Toth, Fairchild AFB, DSN 657-5995)

Absorbent Pad Centrifuge: This system has a start up cost of $30,000, which can be recovered in 3.5 years. The centrifuge dries the pads to non-detectable volatile levels and the pads can be reused up to four times. The pads are disposed of as non-hazardous waste, which results in cost savings of 17 cents per pound compared to soaked hazardous pads. (POC: MSgt Michael Chupa, McChord AFB, DSN 984-3010).

According to Chief McDonald, the success of AMC's P2 initiatives comes from the systematic approach used in the field to address P2 issues. The field maintainers attempt to buy only what they need, use everything they buy, and minimize throwing away waste. HQ AMC/LGBE provides technical support as needed, facilitates cross-exchange within the units, and "knocks down roadblocks" as they arise. The continued success of AMC's program will depend on how effective the Command continues to be in implementing source reduction initiatives and fostering the ongoing cultural change by making "environmentally friendly," effective materials available to the maintainers.

For further information regarding these successful initiatives, please contact the field POCs directly or Chief McDonald at HQ AMC/LGBE at DSN 576-8949.◆

AIR EDUCATION TRAINING COMMAND (AETC)

Air Education Training Command (AETC) recruits new people into the U.S. Air Force and provides them with military, technical and flying training; as well as precommissioning, professional military and continuing education. The command has responsibility for approximately 1,600 aircraft.

At the Headquarters, HQ AETC/LG-EV addresses weapon system Environment, Safety, and Health (ESH) issues. One of the major initiatives undertaken by AQ AETC/LG-EV was to engage with the System Program Office (SPO) to incorporate ESH requirements into the Operational Risk Document (ORD) for the Joint Primary Aircraft Training System (JPATS). This was the first ORD that incorporated ESH concerns.

According to Rich Freeman, Branch Chief, the key to ESH integration from the "customer's perspective" is to understand the ESH cost of doing business, and to balance the acceptable level of risk to meeting mission requirements. This requires keeping process level installation efforts moving forward while changing policy and procedures to integrate ESH into existing processes. Currently HQ AETC/LG-EV has completed the ESOH Technology Needs Planning, Programming and Budgeting Guide. This document will be available on the ESOH TPIPT web site (see related article on page 11) and will facilitate ESH integration into the Mission Support Plans (MSPs). Incorporating ESH considerations into MSPs ensures these issues are considered in the Air Force's strategic planning process.

For further information regarding the ESOH Technology Needs Planning and Budgeting Guide, please contact CMSgt Long at DSN 487-6850.◆

OVERVIEW OF THE TRAINING SYSTEM PROGRAM (ASC/YT)

Max Delgado

Currently, ASC/YT manages the T-1A, T-6A, and the T-38C Training System Programs. Figure 3 provides an overview of the T-1A, T-6A, and the T-38C programs. Raytheon is the prime contractor for the T-1A and T-6A, and Boeing is the prime contractor for T-38C. For these training systems, the Environment, Safety, and Health (ESH) Program, managed by Max Delgado, reports directly to Col. C.R. Davis SPO Director and Gary Stanley DOE. As such, ESH decisions are integrated into both strategic planning and technology development opportunities.

YT Mission: A group-level organization responsible for development, production, deployment, and sustain-ment of DoD's next generation pilot training systems worth over $5B. Three separate and interrelated pilot training systems consisting of over 1600 aircraft, over 140 simulators, and all associated ground school training needed to provide top quality pilot training for all undergraduate Air Force and Navy pilots well into the 21st century.

T-1A Training Systems Program
Program Manager - Todd Eisenhut
Contract - Air Vehicle Sustainment (CLS)
- Buys Aircraft Sustainment and Spares for 180 a/c. Period of Performance ends 30 Sep 99

Contract - Ground Base Training System (GBTS) Sustainment (CLS)
- Buy 9 Simulator, 14 Part Task Trainers, Instructors, Courseware, and Sustainment
- Period of Performance ends 30 Sep 06

T-6A Training Systems Program
Program Manager - Lt. Col. Ronald Joseph
- Joint USAF/USN Program - USAF Lead Service
- Congressional Pilot Program
  - Streamlined Acquisition - Commercial Practices
- T-37/T-34 Replacement
  - FY01 Start of Student Training
- 740 Aircraft and GBTS
- 109 Simulators
- Training Information Management System (TIMS) will replace training management systems currently in use by AETC and CNATRA
- Support Operational Assessments, MOT&E, and GBTS
- Classroom & Computer Assisted Instruction
- CLS for Training System

T-38 Avionics Upgrade Program
Program Manager - Cathy Cliett
Major Modification Program Consisting of a Total Avionics Upgrade to the AT/T-38 fleet ($616M cost)
- Integrated Avionics Modernization includes:
  - Correction of Current T-38 Avionics Training Deficiencies
    - » Complies with GPS Mandate
    - » Improves R&M
    - » Modernizes Ground Based Training System (GBTS)
    - » Provides Ten Year for 509 a/c Sustainment (CLS) and 32 Aircrew Training Device (ATD)

Figure 3. Overview of T-1A, T-6A, and the T-38 Programs

The Environmental Points of Contact for each of these programs are provided in Figure 4. Max Delgado uses these focal points to execute YT™'s ESH Program in a manner similar to an Environmental Working Group (EWG).

Name	Organization	Phone
T-1A		
CMSgt James O. Long	HQ AETC/LG-EM	DSN: 487-6850
Mrs. Sandy South	Columbus, MS, QAE/AFB	Phone: (601) 856-2274
Mr. Doug Oliver	Raytheon Aircraft Co.	Phone: (316) 676-8626
T-6A		
Michael J. Stock	HQ AETC/LG-EM	DSN: 487-6850
CMSgt James O. Long	HQ AETC/LG-EM	DSN: 487-6850
Mr. Doug Oliver	Raytheon Aircraft Co.	Phone: (316) 676-8626
T-6A		
CMSgt James O. Long	HQ AETC/LG-EM	DSN: 487-6850
Mrs. Nancy Kaatman	Boeing Co./S.L. MO	Phone: (314) 233-9041
Mr. Richard Linznier	Boeing Co./Mesa, AZ	Phone: (602) 891-9610

Figure 4. Points of Contact for T-1A, T-6A, and the T-38 Programs

Some of the success stories, funded directly by Raytheon at its facility in Wichita, KS, include the following:

- Substitution of MIL-P-23377D epoxy resin, containing MEK, MIBK, toluene and xylene, with a high solid/low VOC epoxy primer.
- Conversion of alodine 600 to alodine 1200 for batch processing to provide enhanced corrosion protection to aluminum parts.
- Replacement of MEK with MPK as a cleaning solvent.
- Elimination of toluene and xylene from the formulation of a chem-mil maksant.
- Conversion to a high solids/low VOC primer and paint, thus reducing the use of MIBK, MEK, xylene, and toluene.
- Implementation of high pressure low volume (HVLP) and electrostatic paint application equipment for compliance with the Clean Air Act.
- Elimination of cyanide from cadmium plating.

For further information regarding the YT ESH Program, please contact Mr. Max Delgado at DSN 674-4222 or commercial at 937-904-4222.◆

AIR FORCE SPACE COMMAND (AFSPC)

Air Force Space Command (AFSPC) makes space reliable and routine for the warfighter by continuously improving the command's ability to provide and support combat forces – assuring America's control of space. In addition, the command's ICBM forces deter any adversary contemplating the use of weapons of mass destruction. Figure 5 summarizes the types of weapon systems and the installations supported by AFSPC.

Air Force Space Command (AFSPC)	
Weapon Systems (Partial)	**Installations**
➡ Ballistic Missiles (e.g., Minuteman, Peacekeeper ICBM Helicopter Support)	➡ Cape Cod AFB, MA
➡ Rockets (Atlas, Titan Space Shuttle)	➡ Cape Canaveral AS, FL
➡ Satellites (e.g., DMSP, NPOES, GOES)	➡ Patrick AFB, FL
➡ Communications	➡ Eglin AFB, FL
➡ Threat Warning	➡ New Boston AS, NH
➡ Other	➡ Offutt AFB, NE
	➡ Cavalier AS, ND
	➡ Minot AFB, ND
	➡ Grand Forks AFB, ND
	➡ Buckley AFB, CO
	➡ Schriever AFB, CO
	➡ Holloman AFB, NM
	➡ Socorro AFB, NM
	➡ Cheyenne Mtn. AS, CO
	➡ Peterson AFB, CO
	➡ F.E. Warren AFB, WY
	➡ Malmstrom AFB, MT
	➡ Beale AFB, CA
	➡ Onizuka AS, CA
	➡ Vandenberg AFB, CA

Figure 5. Overview of Weapon Systems and Installations Supported by AFSPC

Mr. Dan Rodriguez, HQ AFSCPC/CEVV, is responsible for the MAJCOM's Weapon Systems Pollution Prevention Program. Launch waste, missile maintenance, and radar maintenance are the three major areas of environmental concern within the command. Air Force Research Laboratory (AFRL) is conducting basic research around the area of launch wastes. To support this basic research effort, AFRL has teamed with NASA to evaluate potential alternatives to reduce the scrubber liquor waste, AFSPC's largest waste stream. In the existing process, nitrogen tetroxide vapors generated during rocket fueling are scrubbed with sodium hydroxide, a very corrosive liquid. Launch waste generates 289,000 lbs. of hazardous waste annually at Cape Canaveral AS.

As with other commands, corrosion prevention is a major maintenance activity at AFSPC that creates an environmental impact. Corrosion control requires the use of chromate paints, resulting in waste generation for missile and radar maintenance. For example, the use of chromate paints in missile maintenance results in the generation of 5,000 pounds of hazardous waste per silo.

Working in concert with other organizations, such as AFRL and the Corrosion Program Office, HQ AFSCPC is striving to reduce its top waste generation sources. However, the growing space program within the Air Force requires that the command be more actively involved in the front-end development of future weapon systems. As such, Mr. Rodriguez is working with SMC to ensure that the MAJCOM is integrated into up-front ESH issues for current and upcoming systems.

For further information about AFSPC's weapon systems pollution prevention program, please contact Mr. Dan Rodriguez at DSN 692-3846.◆

PACIFIC AIR FORCES (PACAF)

Pacific Air Forces (PACAF), headquartered at Hickam AFB, HI, provides ready air and space power to promote U.S. interests in the Asia-Pacific region. The command has personnel serving in nine major locations and numerous smaller facilities, primarily in Hawaii, Alaska, Japan, Guam and South Korea.

At the command level, weapon system pollution prevention (WSP2) activities are imbedded under the overall Environmental Quality (EQ) Program. Currently, Mr. Robert Leong, HQ PACAF/CEVQ, manages the command's WSP2 Program, which is still in its infancy. To bring all the appropriate stakeholders to the table, HQ PACAF/LG is looking to establish a permanent position to support Command WSP2 activity.

In FY98, HQ PACAF/CEVQ conducted a command-wide opportunity assessment at all its installations on the ten EPA-17 chemicals and hazardous waste. The assessment identified potential opportunities related to aircraft painting, aerospace ground equipment painting, solid film lubricant, corrosion prevention compounds, and jet washer rinseate. Implementation of the recommended substitutes first requires approval from the System Program Offices (SPOs) to change the associated Technical Order (TO). Mr. Leong is looking towards Air Force Materiel Command (AFMC), and specifically the Center Working Group (CWG), to facilitate the cross-feed/exchange between his MAJCOM and the Single Manager (SM) community.

HQ PACAF has completed and submitted an inventory of its compliance sites to Air Staff. The command has approximately 7,500 compliance sites with an average compliance burden of $3200 per site. Developing the Compliance Site Inventory (CSI) for PACAF was unique compared to other MAJCOMs because international environmental regulations had to be considered in defining a compliance site.

For further information regarding PACAF's activities, please contact Mr. Robert Leong at DSN (315) 449-6536.◆

AIR FORCE MATERIEL COMMAND (AFMC) POLLUTION PREVENTION CHIEF SPEAKS WITH THE MONITOR

Major Lyn Gemperle has been addressing environmental issues in the Air Force for the last 10 years. Currently, she is serving as the Pollution Prevention (P2) Division Chief at Air Force Materiel Command (AFMC). Major Gemperle spoke at the 13th AFMC Center Working Group and with the MONITOR regarding the Air Force and AFMC P2 Program.

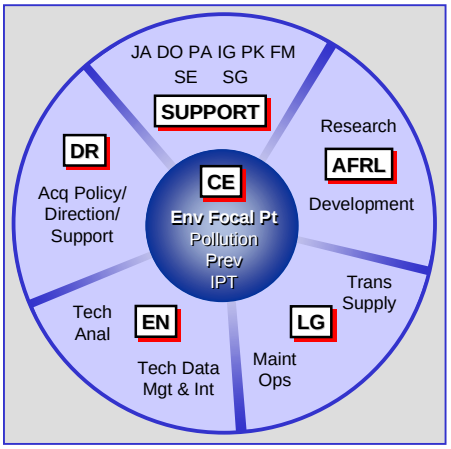
Q. Looking back over your experience, how has the Environmental Program in the Air Force evolved?

A. In the 1970s and early 1980s, the Surgeon General (SG) community was informally responsible for the Air Force's environmental program. The Bioenvironmental Engineer (BEE) assessed potential environmental concerns primarily though shop surveys. In essence, the BEE was adopting an ESH mindset when conducting these surveys. However, they often did not have access to the appropriate functional areas (e.g., civil engineers, and maintainers) to properly address identified concerns.

In the early 1980s, Civil Engineering (CE) became responsible for the Air Force Environmental Program as emphasis was placed on increased regulatory requirements. While CE focused on environmental compliance and restoration, the "S & H" perspective within this framework was somewhat diminished. We are now coming back a full circle to the realization that although we can achieve environmental compliance in a number of different ways, the optimum process requires adopting an ESH/P2 perspective. P2 is a crosscutting field that helps the Air Force achieve compliance "better, smarter, and faster" by creating a place where the "S & H" can have a voice at the table.

Q. As the AFMC Pollution Prevention Branch Chief, how does your organization conduct its business in this crosscutting field?

A. The P2 Branch at AFMC focuses on "solving tomorrow's environmental challenges today!" We conduct our business through the Pollution Prevention Integrated Product Team (P2IPT). This cross-functional team is chartered through the Environmental Protection Committee (EPC) and continues to demonstrate that crosscutting issues are best solved through this forum. The P2IPT has made significant impact to P2/ESH considerations in the Air Force and is often looked towards by the Air Force and other MAJCOMs for leadership. As I said at the Center Working Group Meeting, every MAJCOM should consider executing their program through an IPT structure.



P2IPT Structure for Functional Integration

Specifically at AFMC, 43% of our business is related to operation and maintenance issues, 35% is related to weapon systems, and 22% of our business addresses compliance through P2. The bottom line is that the AFMC P2 Program directly affects the rest of the Air Force and we need the other MAJCOMs involved in our efforts. The last CWG, hosted at ACC, was an excellent start in bringing together the P2 acquisition, sustainment, and installation communities in the Air Force.

Q. What is your future vision for the AFMC P2 Program?

A. My vision is that we need to continue to "tear down the walls" and share resources for the overall benefit of the Air Force. Within AFMC, one of our challenges is to truly marry the installation and weapon system pollution prevention programs. The "big bang for the buck" will come from new technology implementation and process changes into the weapon system P2 community. Such technology insertion will have direct impact at the installation level and is inherently tied to our existing CTP2 initiative. From my experience, the BEEs bring a unique perspective to the table and I encourage the SG community to continue placing resources against ESH/P2 related issues. Such collaborations, across the diverse functional areas, from base, headquarters, and Airstaff level will create the synergy for exciting innovation in the future.

On 31 Dec 99, Major Gemperle will separate from the Air Force. Her contribution and leadership to the AFMC Pollution Prevention Program have been greatly appreciated. We would like to thank her for her leadership and extend best wishes for the future.◆

INSTITUTE FOR ESOH RISK ANALYSIS

The Institute for Risk Analysis (IERA) is an Air Force Materiel Command (AFMC) organization dedicated to enhancing mission effectiveness, protecting health, improving readiness, and reducing costs through the assessment of risks to human health and safety, operational performance, and the environment. IERA is organized into three units: the Risk Analysis Directorate, the Operations Directorate, and the Surveillance Directorate. IERA is capable of providing specialized teams in the areas of epidemiology, and in chemical, radiation, and biological assessment to deployed Air Force organizations. IERA's many activities include providing support to the weapon system Pollution Prevention community.

Some of IERA's programs in support of weapon system pollution prevention include projects in corrosion control, JP-8 jet fuel, and Reduction in Total Ownership Costs (RTOC).

- IERA chairs the Corrosion Control IPT. IERA's mission is to evaluate the environment, safety and occupational health (ESOH) impacts of new and existing corrosion control products, processes and technologies, with a goal of reducing ESOH risks to Air Force personnel by reducing or eliminating potential health hazards in weapon systems and industrial programs. Recent successes include an evaluation of the Sempen Polyurethane Applicator that determined that no respirators were required, obtaining a change to Air Force policy on the use of supplied air respirators when using isocyanate paints, and recommending standard PPE and engineering controls for fiberglass and composite material repair operations.
- IERA also chairs the JP-8 Jet Fuel IPT. This IPT is evaluating the mission impact of JP-8 jet fuel on human health and the environment. IERA is helping to identify, evaluate, and recommend operational solutions to exposure and environmental impacts. The effects of JP-8 fuel exposure in a variety of potential exposure situations are being studied. Nine different types of aircraft located at Air Force and Air National Guard Bases around the country were studied during the JP-8 evaluation.
- SAF/MIQ interest in activity based costing (ABC) for ESOH costs associated with weapon systems led to two efforts intended to reduce total operating costs (TOC). In support of HQ AETC and Randolph AFB, IERA met with shop staff, and developed and evaluated process efficiency improvements with anticipated annual savings of $50K-$100K and payback periods ranging from immediate to 2.5 years. The next effort on reducing TOC will be done in conjunction with paint/depaint processes at Robins AFB.

For additional information on IERA, contact the ESOH Service Center at DSN 240-5454 or http://sg-www.satx.disa.mil/iera/index.htm.◆

AIR FORCE CORROSION PREVENTION AND CONTROL OFFICE

The Air Force Corrosion Prevention and Control Office (CPCO) was created to ensure that the Air Force has a viable program to minimize the effect of corrosion on Air Force systems by implementing a comprehensive program to prevent, detect, and control corrosion. The Corrosion Prevention and Control Office is a subset of the Air Force Materiel Command and the Air Force Research Laboratory. The office is located at Robins AFB, Georgia, and consists of both military and civilian staff members. The office has laboratories specially equipped for corrosion research.

The mission of the CPCO is specified in Air Force Instruction 21-105. The CPCO accomplishes its mission through specific engineering and technical focal points. These missions include:

- Implementing the USAF Corrosion Prevention and Control Policy;
- Engineering responsibility and user support for Tri-Service Technical Orders (TO): TO 1-1-691, TO 1-1-689 and TO 1-1-686; and for Air Force TOs: TO 1-1-4 and TO 1-1-8;
- Technology insertion;
- Dem/Val of new technologies at air logistics centers (ALC) and at field units; and
- Providing engineering and technical consultation support.

The CPCO conducts periodic MAJCOM surveys focused on selected work centers, the products in use, and the processes work centers are using for corrosion control. The CPCO has obtained significant, extensive information about practices that are important for a successful corrosion control program, and has made this information available on the CPCO website. The CPCO provides information on recent changes to TOs, Qualified Products List (QPL) materials, and other significant information impacting corrosion prevention and control. The CPCO's intention in its website is to assist the Wing Corrosion Manager in disseminating information to everyone involved in preventing corrosion. Current information available on the website, of interest to all work centers, includes guidance on writing Maintenance Operating Instructions (MOIs), information on MIL-A-46146 non-corrosive sealants, advice on the use of corrosion prevention compounds (CPCs), recommendations on aerospace cleaning compounds, and a checklist for use in assessing local occupational health concerns.

The CPCO website also contains specific, focused information of relevance to the individual work centers typically found on an air force base. The website provides precise guidance that integrates technical information about corrosion control procedures with pollution prevention recommendations. This information is tailored to shop operations and provides a fast and effective way of obtaining information of immediate relevance to daily maintenance operations.

The CPCO has several ongoing projects of interest to the acquisition P2 community. One significant long-term effort is their project to quantify the total dollar cost of corrosion Air Force-wide. This research has resulted in valuable management information for senior Air Force decision-makers. The CPCO is continually evaluating ways to improve technical maintenance procedures for corrosion control, and serves as a central clearing house for information on approved changes in all aspects of corrosion control. One area of investigation is the CPCO's efforts to standardize aqueous parts washing procedures in a way that makes best use of the inherent pollution prevention advantages of aqueous cleaning technology without compromising the structural integrity of Air Force weapon systems.

For additional information, contact the Air Force Corrosion Prevention & Control Office at DSN 468-3248 or commercial (912) 926-3284, commercial FAX (912) 926-6619. Their e-mail is afcorr@robins.af.mil. The CPCO's website address is http://www.afcpo.com.◆

THE ENVIRONMENT, SAFETY, AND OCCUPATIONAL HEALTH (ESOH) TECHNICAL PLANNING INTEGRATED PRODUCT TEAM (TPIPT) SUPPORTS AIR FORCE MAJCOMS THROUGH WEB-BASED PRODUCTS

The Environment, Safety, and Occupational Health (ESOH) Technical Planning Integrated Product Team's (TPIPT's) web based products are available at http://xre22.brooks.af.mil/hscxre. Figure 6 (on page 12) outlines a series of products that are linked to the Technology Needs Collection process and are further discussed on the next page.

All new needs identified by various AF MAJCOMs can directly be entered into the ESOH TPIPT process through this web-based product (Screen 1). Additionally, any submitter can receive real time information regarding the current status of a submitted need (Screen 2). As Figure 6 shows, the existing needs can be viewed by different criteria (Screen 3). For example, Need Status Report can be viewed by submitting organizations, which include all AFMC bases as well as other MAJCOMs such as Air Combat Command (ACC), Air National Guard (ANG), and Air Mobility Command (AMC) (Screen 4).

Pointing the browser to one of these organizations provides another screen listing all the needs associated with that organization (see Screen 4 for listing of OC-ALC Needs). In our example, if we look at Need 101 for OC-ALC, "Replacement for Chromate Conversion Coatings for Aluminum and Magnesium on Aircraft", we see in Screen 5 that Need 101 is still active. Other details related to this need can be directly accessed from Screen 5. For example, Screen 5 gives direct access to a detailed description of the original need, the Need Assessment Summary (NAS) associated with the need, and ongoing AFRL projects that support this need. In our example, there are three different AFRL projects that can be leveraged in determining a solution for this need.

Other useful information available on the ESOH TPIPT web page includes "Emerging Issue." This product identifies compliance-based ESOH issues that have not yet fully impacted the Air Force but have the potential to do so in the near future. The ESOH TPIPT lists these emerging issues and, upon sponsorship from a MAJCOM, prepares a paper related to the topic at hand. The ESOH TPIPT has also formed a Systemic Working Group that looks at common needs (e.g., deicing) from a macro/holistic approach. The ESOH TPIPT is planning to meet with all Air Force MAJCOMs in early December to discuss the status of the ESOH TPIPT Needs and the future direction of this organization.

For further information regarding the ESOH TPIPT or the upcoming meeting in December, please contact Lt. Col. Pamela Buhr at DSN 240-4466 or commercial at (210) 536-4466.◆

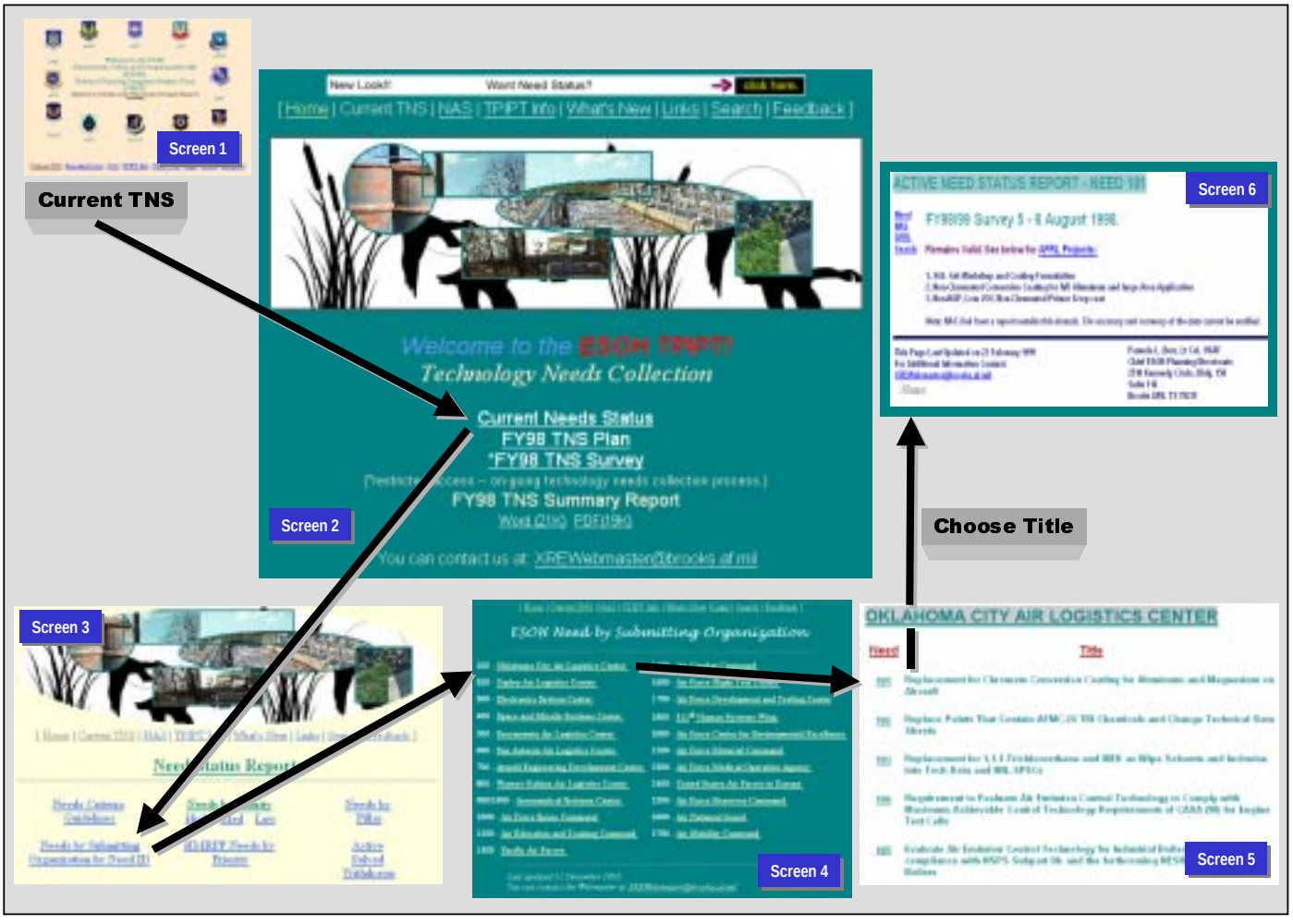


Figure 6. Overview of the ESOH TPIPT Web-Based Product

Policy Update

COMPLIANCE THROUGH POLLUTION PREVENTION (CTP2) PROGRAM UPDATE

In August 1999, USAF/ILEVQ conducted its 1999 Environmental Quality Workshop in Arlington, TX. The conference included a breakout session on Compliance through Pollution Prevention (CTP2), which was attended by representatives from Air Force MAJCOMs. During this session, a variety of issues related to the implementation of the draft AFI 32-7080 were discussed and consensus on solutions achieved. The members of the CTP2 working group resolved questions related to the compliance site database, compliance site costs, risk models, and metrics for measuring program success. Some of the resolutions from this conference are included with the discussion of Air Force Materiel Command's (AFMC's) CTP2 Program, provided below.

Overview of AFMC's CTP2 Program

Figure 7 provides an overview of a CTP2 Program, as defined in AFI 32-7080. This diagram was developed in accordance with EPA's Code of Environmental Management Principles (CEMP) and represents the approach that AFMC will take in implementing the three phases of the Air Force CTP2 Program, as defined in AFI 32-7080.

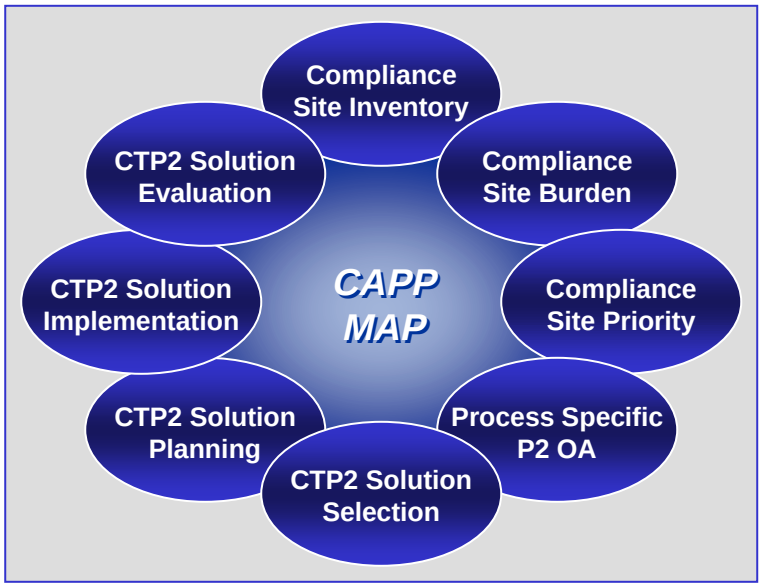


Figure 7. Overview of the CTP2 Program at AFMC

Phase I - Conduct Compliance Site Inventory

In July 1999, AFMC completed Phase I of the CTP2 Program by finalizing its Compliance Site Inventory (CSI). During Phase 1, approximately 18 compliance sites were identified at AFMC installations. Figure 8 shows the breakdown of the identified compliance sites by media. AFMC's CSI includes 12 active installations. Kelly AFB, McClellan AFB and Aeronautical Systems Center's (ASC's) government owned-contractor operated (GOCO) plants are not included in the CSI. The number of compliance sites at the 12 active installations ranges from 59 sites to 3,267 sites.

At the ILEV Conference, the CTP2 working group resolved that the CSI will be used as a management tool by the installations and as an oversight/trend analysis tool by MAJCOMs/Air Staff. The CSI data will not be used as a resource allocation tool or mechanism. The CSI's most significant use will be as a pointer, or guide, to indicate where to conduct a focused, process-specific opportunity assessment (OA) most effectively. Specific data fields will be identified by ILEVQ for reporting; the database will be centrally maintained with semi-annual data calls.

Phase II - Evaluate and Prioritize CSI Based on Cost and Risk

In preparation for Phase II of the Air Force CTP2 Program, which requires completing compliance site prioritization by October 99, AFMC has been conducting the following activities. A team is assessing the compliance burden associated with each site. Cost and risk data are being collected and assigned to these sites using cost distribution spreadsheets and a risk algorithm.

At the ILEV Conference, the CTP2 working group resolved that total ownership costs (TOC) will continue to include ESOH, O&M and process owner costs. TOC data will not be reported until an OA is complete and accurate process owner data is available.

Additionally, the group resolved that the standard ORM approach, explained in AFI 32-7080, would continue to be used. Hazardous Material Management Program (HMMP) teams may use additional risk algorithms to further quantify risk. Sites will be prioritized by the installation after they are grouped by process or building.

Phase III - Target High Burden Sites with Process-Specific Opportunity Assessments

AFMC is now developing guidance and tools for implementing the rest of the CTP2 process. The proposed web-based CAPP Management Action Plan (MAP) format, which is being developed to replace the P2 MAP, will provide installations with the tools and links needed to incorporate the CTP2 process into their environmental programs. One of the links will be the installation's CSI. Another will be the results of process-specific opportunity assessments (OAs). OAs now need to focus on the highest priority groupings of compliance sites, based upon compliance burden, mission impact, etc. A new, site-based OA format is under development and should be completed in 1999. P2 alternatives identified in the course of a OA should lower the associated compliance burden and, in doing so, provide a reasonable return on investment. To evaluate the return on investment, a model using the TOC for the activity is also being developed.

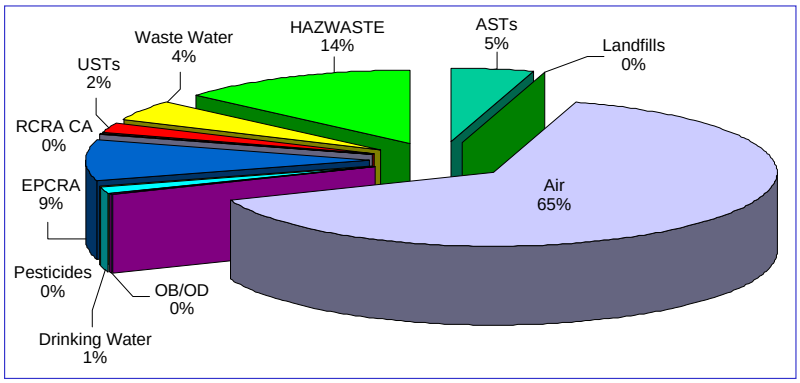


Figure 8. Breakdown of Compliance Sites by Media

Wrap-up

At the ILEVQ breakout session, the CTP2 group agreed that there was a need for a metric capable of clearly and quickly showing Air Force progress. The group tentatively decided that the metric should start with a "baseline" burden and show progress, or a downward trend, over time.

For more information regarding AFMC's CTP2 Program, please contact Steve Coyle at DSN 787-7414. For additional information regarding the ILEVQ CTP2 breakout session, please contact your MAJCOM. ◆

AEROSPACE ACTIVITIES WILL BE COVERED BY THE METAL PRODUCTS & MACHINERY RULE

Many environmental, safety and health issues are common across government and commercial facilities that manufacture aerospace products, fly the products, or maintain them. An example of such an issue is the Metal Products & Machinery Rule (MP&M) which was proposed by EPA on May 30, 1995. The rule, which set pollutant limits for wastewater discharges, covered over 10,000 facilities working in the following industrial sectors: aerospace, aircraft, electronic equipment, hardware, mobile industrial equipment, ordnance, and stationary industrial equipment.

Analyzing the proposed rule was complicated by its complexity and the sheer volume of background information available from EPA. Nevertheless, after an exhaustive review, Aerospace Industry Association (AIA) concluded that the rule would impose unreasonably large costs on affected facilities for minimal environmental benefits. AIA and other affected organizations submitted detailed comments and met with EPA repeatedly to express concern with the proposal, resulting in EPA's withdrawal of the proposed rule. However, EPA will reissue the rule along with a Phase II MP&M proposal which will also cover buses and trucks, household equipment, instruments, motor vehicles, office machines, precious and nonprecious metals, railroads, and ships and boats. While facilities with water flows less than 1,000,000 gallons per day were exempt from the 1995 proposal, EPA is reexamining the exemption cutoff.

AIA and other interested associations and companies have formed an ad hoc coalition to monitor the progress of the MP&M rule and provide input to EPA upon request. Industry has made plain its eagerness to work cooperatively with EPA as the revised rule develops, by reviewing and commenting on new information shared with the coalition. EPA last met with the coalition on June 30, 1999, to brief the coalition on the rule's progress. AIA believes that by committing its resources to such activities, we bring benefits to our customers, such as DoD, as well as our own companies. Federal facilities have recently completed a voluntary survey to supplement the data that EPA has collected for the rule. The MP&M, including both Phase I and II, is now due to be proposed by October 2000, with finalization of the rule mandated by December 2002 under a court decision. The EPA web site for the MP&M is at www.epa.gov/OST/guide/related/metalprod.html but little information is available yet at the site. Minutes of the June 30 meeting can be found on the

"Documents of Interest" page at the AIA Environment, Safety & Health (ES&H) web site at www.aia-aerospace.org/homepage/esh/index.html.

This article was submitted by Ms. Mary Spencer on behalf of Glynn Rountree from Aerospace Industry Association of America (AIA). AIA represents the United States' leading manufacturers of commercial, military, and business aircraft, helicopters, aircraft engines, missiles, spacecraft, and related components and equipment. Among other activities, AIA's Environmental, Safety & Health Committee works jointly with the Department of Defense and other customers to help federal agencies develop regulations that meet the intent of legislation while holding down costs and maintaining choices for achieving compliance.◆

Design for the Environment

DFE AND LEAN PRINCIPLES

I recently attended a "lean" orientation training session. The purpose of the training was to introduce the lean principles and to present an overview of the Lean Enterprise Model (LEM). I enjoyed the class and received a better appreciation for the lean philosophy. As the class progressed, I began to see similarities between Design for the Environment (DFE) and the Lean Aerospace Initiative (LAI). DFE and LAI are both database driven. DFE and LAI both look to minimize waste, optimize time, efficiency and resources. Both deal with alternative methods and materials to be efficient, and both look for cost savings. My analysis may be an over-simplification of the two programs; nonetheless, DFE and LAI are very compatible.

One of the additional benefits of LAI (for DFE personnel) is related to access for decision making. Individuals who work on DFE can use LAI as a method to become involved with the design of a process from the beginning.

An example of the similarities between DFE and the lean philosophy is noted in the lean terminology CLOSEDMITTS. The acronym is used to describe how the lean process deals with waste in a process. Figure 9 shows a portion of the meaning for the acronym.

C The waste of ***Complexity***
L The waste of ***Labor***
O The waste of ***Overproduction***
S The waste of ***Space***
E The waste of ***Energy***
D The waste of ***Defects***
M The waste of ***Materials***
I The waste of ***Idle Materials***
T The waste of ***Time***
T The waste of ***Transportation***
S The importance of ***Safety***

Figure 9. CLOSEDMITTS

As I read the CLOSEDMITTS waste reduction tasks, I began to see how DFE and lean practices overlap applications. Figure 10 (on page 16) shows my notes on how DFE actions match up to the lean waste program. Not everyone will agree with my DFE comments to CLOSEDMITTS. Your manufacturing, engineering, or design facility may be different than mine. Take the time to create your own DFE – lean CLOSEDMITTS analysis. Find your own overlap.

All of this begs the questions. What are you, the DFE expert, doing to support lean enterprises? Are you, the facilities expert, a member of a lean team? Do you, the environmental project lead, provide assistance and an environmental overview for lean enterprises? Do you, the environmental design or manufacturing engineer, work with the lean team as they analyze alternative materials and processes? Do you, the HAZMAT expert, provide guidance when a change in process may affect waste disposal? Do you, the compliance lead, act as an advisor to explain how local, state and federal EPA rules can affect a process? Do you, the environmental health and safety expert, provide guidance on health and safety training as lean processes change? If the answer is yes to participation on a lean team, then keep up the good work. If the answer is no, then why are you not involved?

DFE has a direct application for the support of lean projects. DFE and LAI are very complimentary of each other. DFE and LAI are involved in making manufacturing processes efficient and compliant. DFE and LAI are both involved in the identification, classification and disposition of waste. LAI uses a method that encourages DFE personnel to become involved in changing processes and procedures from the beginning. The ability for DFE personnel to become involved in analyzing new processes and procedures is a sensitive topic. The lean principle is the vehicle you can use to open doors. Create your own CLOSEDMITTS DFE/lean matrix and become involved. For more information on the MIT

Lean Enterprise Model or the Lean Aerospace Initiative, visit the MIT website at http://web.mit.edu/lean.

Fred Missel is the Boeing–Mesa representative to the Joint Arizona Consortium for Manufacturing, Education and Training committee on Design for the Environment. He is a co-author of the course, "Design for the Environment for Integrated Product Development." He may be reached by phone at (480) 891-5648, or by e-mail at Fred.R.Missel@boeing.com.◆

Lean	DFE
The waste of ***Complexity***	Simplify EPA rulings and directives for in plant use
The waste of ***Labor***	Make sure that the location of wipes, etc., are convenient
The waste of ***Overproduction***	On time production means less HAZMAT scrap disposal
The waste of ***Space***	Make sure HAZMAT storage areas are well organized
The waste of ***Energy***	Choose processes that reduce water and electrical consumption
The waste of ***Defects***	Reduce cost to replenish approved paints, coatings, oils
The waste of ***Materials***	Effective selection of alternative materials
The waste of ***Idle Materials***	Manage HAZMAT inventory that requires special storage
The waste of ***Time***	Time saves money
The waste of ***Transportation***	Decreased waste means decreased "tipping" fees
The importance of ***Safety***	Safety training saves lives, materials and down time

Figure 10. DFE/Lean Comparison

EPA'S DESIGN FOR THE ENVIRONMENT (DFE) PROGRAM
"Helping Business Help the Environment"

"The DFE program forms partnerships with business, industry and government to incorporate environmental considerations into their every day business decision. Factoring the environment into business decisions saves money and improves environmental performance."

– Bill Hanson, Chief, Design for the Environment Program

The Design for the Environment (DFE) program was initiated in 1992 by EPA's Office of Pollution Prevention and Toxics. The program's objective is to help businesses incorporate environmental considerations into the design and redesign of products, processes, and technical and management systems. The DFE program relies upon voluntary partnerships with industry, universities, research institutions, public interest group, and other government agencies.

The concept of DFE incorporates environmental concerns into the traditional decision-making parameters of the business world: cost and performance. The program finds ways to build incentives for behavioral change and continuous environmental improvement.

To accomplish these goals, the DFE Program uses EPA expertise and leadership to evaluate the environmental and human health risks, performance, and cost of both traditional and alternative technologies, processes, and materials. DFE disseminates information on its work to all interested parties and also assists businesses in implementing new technologies and processes identified through the program. The DFE program has formed cooperative partnerships with industry, professional institutions and trade associations, academia and research institutions, environmental and public interest groups, and other government agencies.

The DFE program is currently partnering with the U.S. Navy in a cooperative project to implement the DFE philosophy during the development of the Virginia class submarine. The EPA and Navy DFE programs are collaborating to develop case studies that discuss pollution prevention opportunities for the businesses in the Navy's supply chain. For example, one of the Navy's suppliers of compressor parts, RIX industries in Benecia, CA, learned of Navy Oxygen Cleaner (NOC), an aqueous, inorganic, alkaline solution which the Navy had developed for cleaning parts that will be exposed to an oxygen environment. RIX switched to NOC, and purchased a closed loop parts washer. With this system, the facility has minimized discharges and extended the life of the cleaner indefinitely.

The Navy has made environmental concerns an integral part of the weapon system development process. To facilitate pollution prevention, the Navy provided Electric Boat with the Navy's Virginia Class Hazardous Materials List, a list of 70 materials to be minimized throughout the life cycle of the submarine. Electric Boat, in turn, provided the list to RIX, and suggested that RIX replace the ethylene glycol which RIX was using as a corrosion inhibitor in the submarine's closed loop cooling system with propylene glycol, a less toxic material. Based on technical information provided by

Electric Boat, RIX determined that propylene glycol was a suitable replacement as a corrosion inhibitor for all other uses of ethylene glycol in the company, including booster compressors, cooling towers, and company vehicles.

The significant lesson learned from the EPA DFE and Navy partnership is that simple process changes and conscientious design can have substantial environmental benefits while improving process efficiency and lowering costs. RIX's successes with technical and chemical substitutes demonstrate how good communication throughout a supply chain can have far-reaching benefits.

Another recent DFE project involves a partnership with the printed wiring board (PWB) industry include the Printed Wiring Board Project. PWBs, also known as circuit boards, are the building blocks of most electronic equipment. Traditional manufacturing methods use toxic chemicals posing potential health and environmental risks that generate large volumes of hazardous waste, and use substantial amounts of water and energy. The DFE PWB Project has worked with PWB manufacturers, trade associations, research and academic institutions, and public interest groups to examine alternative technologies that reduce or eliminate these impacts. In its first major study, the project evaluated the health and environmental risks, performance, and cost of the electroless copper process and six promising alternative technologies. The project partners are now conducting a similar evaluation of alternative surface finishes that can replace the hot air solder leveling process.

The US EPA DfE Program has entered into a partnership with the Saturn Corporation and its suppliers and the University of Tennessee's Center for Clean Products and Clean Technologies. The partnership hopes to promote cleaner production practices and reduce pollution through the life cycle of Saturn vehicles, including manufacture, consumer use, and final disposition. The strong relationship between automobile manufacturers and their suppliers presents unique opportunities for making substantial environmental gains that pass down to companies throughout the economy. The supply chain project is a continuation of the Saturn UT partnership that was established in May 1987 to work on projects and issues of mutual benefit to both Saturn and the University of Tennessee.

The DFE program is currently working with the auto refinishing industry and individual shops to increase awareness of the health and environmental concerns associated with auto refinishing and to identify and encourage the use of safer, cleaner and more efficient practices and technologies. The Auto Shop project's strategy is straightforward: the use of more efficient equipment and practices will help prevent pollution before it is created and appropriate protective equipment and control technology will reduce worker and environmental exposure and risk. In consultation with states and local stakeholders, DFE is conducting a pilot project with small shops in the Philadelphia area; from this experience, DFE has prepared a report on Factors that Motivate Owners of Auto Refinish Shops to Implement Changes, which discusses the primary incentives and obstacles that shop owners face when making improvements in their shops.

The DFE program is using the information gathered through shop visits to develop a blueprint for change and to begin a dialogue between the shops and suppliers of raw materials, equipment, and training, focusing on the challenges of the small shop. This type of exchange can encourage true supply chain product stewardship that closes the loop between chemical manufacture and use. DFE is developing outreach materials that focus on the key components of sustainable change in small auto refinishing shops.

DFE's work with specific industrial sectors is complemented by the development of tools that can be used to assess substitute technologies and other pollution prevention options. These tools include:

- The DFE Environmental Management System (EMS): EMSs can provide companies with a systematic way to improve their operations for better environmental performance. While an EMS supplies the basic management framework, the DFE program provides guidance and tools to help companies achieve continuous environmental improvement.
- Cleaner Technologies Substitute Assessment (CTSA): A Methodology and Resource Guide (EPA 744-R-95-002). The guide describes the methods and resources used by the DFE program to compare the risk, cost, and performance of alternative products, processes, and technologies.
- Use Clusters Scoring System (UCSS): UCSS helps identify and analyze groups of chemicals that are used to perform various tasks and prioritize these groups based on environmental, human health, and safety risks.
- Financial tools: EPA is working with the accounting, insurance, and financial industries to identify and quantify the economic and environmental savings that can be achieved by implementing innovative pollution prevention options.

To obtain more information, visit the DFE home page at www.epa.gov/DFE, or contact Ms. Marla Hendriksson at (202) 260-8301.◆

DoD Cross-Feed

C-17 ADVANCED PERFORMANCE COATING

Long term coating durability is sacrificed in the formulation of low gloss military topcoats. In order to achieve the very low gloss required by the military, coatings must be formulated with large amounts of flattening agents. These flattening agents not only lower the gloss, but also reduce the total amount of resin that can be used in formulating the coating. This can reduce the long-term durability of the coating.

Many aircraft painted with low gloss, high solids polyurethane topcoat have experienced premature oxidation or chalking of the topcoat. The chalking phenomenon results from sunlight-induced ultraviolet (UV) oxidation of the resin. For each type of chemical bond, there is a threshold wavelength below which the bond can be broken. Polymer degradation occurs when radiation of sufficient energy falls upon it to cause breakdown of the chemical bonds that make up the polymer. Chalking is manifested as a severe lightening of the color, usually accompanied with a chalky appearance. A marked decrease in cleanability is also associated with topcoat chalking.

In order to fix this problem, the Air Force issued a pollution prevention contract to the C-17 program to develop an advanced performance coating (APC) for the C-17. An integrated product team was formed to develop the advanced coating. Members of the team included Boeing - Military Aircraft & Missiles Systems Group (Long Beach & St. Louis), the Air Force Research Laboratory (AFRL), the University of Southern Mississippi (USM), TJF Technical Solution Inc. and Battelle Memorial Institute.

Boeing and the AFRL prepared the C-17 APC requirements document for the C-17 Program Office. The document provided target and threshold values for 36 critical coating properties. Battelle and USM provided state-of-the-art accelerated test methods to expedite the downselection phase. Accelerated weathering tests that normally take over 2 months to accomplish were completed in less than a week using electron spin resonance testing.

Nine different coating technologies were evaluated during the APC downselect phase. A total of 24 coatings were formulated and screened. TJF Technical Solutions Inc. was the main formulator. Battelle and USM also provided formulations for evaluation. Commercial paint vendors were solicited to submit an advanced technology coating specifically designed for superior UV stability and cleanability.

A statistical desirability program was developed to downselect an APC candidate. Thirteen tests were selected, with each having a weighting factor associated with its importance to the program. Three materials were downselected for continued development. Two of the materials were fluorine-modified polyurethanes, while the other was a highly branched polyurethane. All three materials showed a 2-3-fold improvement over the baseline coating. The selected candidate had a composite score of 67% compared to the baseline coating's score of 18% (100% is a perfect score).

The selected candidate was a modified high solids polyurethane topcoat. The material is a chemically cured, two component fluoropolyurethane. Fluoropolymers have been used since the late 1960s as architectural coatings. They offer superior weatherability, chemical resistance and colorfastness. Recent advances in polymer technology have improved the workability of the polymers, allowing them to be spray applied. The fluorine atom has a higher electronegativity than any other atom. It also has the smallest atomic radius next to hydrogen. This allows it to form very stable high-energy bonds with carbon. This strong bond is responsible for the coating's UV and thermal stability.

On 25 February 1998, C-17 aircraft P-39 was painted with the advanced topcoat. It took 2 hours to apply the paint to the 20,000 square foot aircraft. One hundred gallons of paint were used. The painters worked from a combination of stacker cranes and work stands using environmentally compliant electrostatic spray equipment. The state-of-the-art Long Beach paint facility is both temperature and humidity controlled.

The aircraft passed customer inspection and was delivered to Charleston AFB, South Carolina, on 15 April 1998. The aircraft has been closely monitored for the past 11 months. An Air Force KC-135 from Tinker AFB, OK, was also painted with the APC in June of last year.

Field evaluation of the C-17 showed a 5-fold improvement over the baseline topcoat with respect to color stability, and a 3-fold improvement with respect to gloss retention. The APC is expected to eliminate overcoat painting of the aircraft between the normal depot cycles. This will result in significant cost savings to the Air Force. Newly delivered C-17s as well as C-17s repainted under Boeing's flexible sustainment contract are anticipated to be painted with the new topcoat. Numerous other programs are interested in the advanced coating.

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Chris Hendrix, C-17 Pollution Prevention, Boeing–Long Beach, (562) 593-5958, christopher.g.hendrix@boeing.com.◆

THE PROPULSION ENVIRONMENTAL WORKING GROUP (PEWG) HOSTS ITS SUMMER MEETING IN MONTREAL, CANADA

The Propulsion Environmental Working Group (PEWG) is chartered by the Joint Propulsion Coordinating Committee to resolve common Environment, Safety, and Health issues across all DoD engine components.

In August 1999, the PEWG held its semi-annual meeting in Montreal, Canada. Pratt & Whitney Canada hosted the three-day meeting and provided PEWG members a plant tour of its local operation that produces the PT6 engine. The Summer PEWG meeting fostered international cooperation within the engine community, discussed alternative technologies to hard chrome for engine components, and provided a forum to cross-feed information regarding ongoing projects.

Mr. John Wright, Pratt & Whitney Canada; Colonel Charles King, Deputy Propulsion Product Group Manager; Commander Larry McCracken, Naval Air Systems Command; and Dr. Kirit Bhansali, AMCOM Redstone Arsenal, provided a top-level international and DoD-wide perspective to the meeting.

The international perspective was further expanded through discussion by Mr. Peter Trau regarding Canada's aerospace industry and through presentations made by Ashok Koul of the National Research Council, Canada Institute for Aerospace Research and by Dr. Prakash Patnaik of the Advance Materials and Energy Systems Orenda Aerospace. Mr. Glynn Rountree provided a status of pending ESH regulations pertinent to the aerospace industry.

Some of the ongoing PEWG projects that were cross-fed at the meeting included the following:

- **T56 Engines – Cadmium Elimination Project** – this project originated because of concerns expressed by the EPA about cadmium in the T56 wash water. Alkaline-Zn-Ni has been selected as the most likely alternative and is being tested at SA-ALC.
- **F100 Engines – Solvent Substitution** – this project focuses on elimination of chlorinated solvents from the F100 rework process at SA-ALC and should be completed by December 1999.
- **JSF Reclamation Process** – this project reclaims and reuses rhenium (Re) from used, non-reparable engine blades. The generated scrap to date is insufficient to execute the project. Pratt & Whitney is looking towards the PEWG for assistance in scrap collection.
- **F101/F110 Engines – Solvent Substitution –** this project qualifies an alternative to methylene chloride used to strip coating from F101/F110 gearboxes for periodic maintenance inspections.
- **Lead-Free Dry Film Lubricants – Test Program** – there are three viable candidates for Phase III of this project: Everlube 813, Everlube 10030, and Tiolube 614-T9B.
- **Vacuum-Based Technologies for Hard Chrome Reduction in GTE Operations** – this project is executed through the Materials and Process Partnership for Pollution Prevention (MP4). NDCEE will identify requirement analysis, identify alternatives, perform technology demonstrations, justify and implement this technology.
- **Replacement of Chrome Plating Using High Velocity Oxygenated Fuel (HVOF) Thermal Spray Coatings** – The PEWG is partnering with the Hard Chrome Alternatives Team (HCAT) on this project. The PEWG/HCAT Team have requested FY00 funding through the Environmental Security Technology Certification Program (ESTCP). Mr. Bruce Sartwell of the Navel Research Lab and HCAT Team Leader, repeated the project proposal briefing he had given earlier in the month to the ESTCP Review Board.

For further information regarding this meeting or other PEWG activities, please contact Mr. Frank Ivancic at (937) 785-0444, ext. 3185, or by e-mail at frank.ivancic@wpafb.af.mil, or visit the PEWG website at www.pewg.com.◆

'OZONATOR' TERMINATES FLUORESCENT PENETRANT WASTE

With a little help from an "ozonator," Hamilton Sundstrand's Windsor Locks, Conn., facility completely eliminated fluorescent penetrant concentrate waste from its operations and saved some $27,000 annually in the process, according to EHS Manager John LaFleur.

Like many UTC operations, Hamilton Sundstrand uses fluorescent penetrant (FP) in non-destructive testing procedures to identify imperfections in parts. The process is simple. A part is submerged in the green, fluorescent, hydrocarbon-based liquid, which becomes entrapped by surface imperfections. After rinsing, the part is passed under a black light that clearly illuminates the entrapped FP and, with it, any imperfections in the part. The part then may be reworked.

But what of the rinsewater?

Since 1994, Hamilton Sundstrand has used an ultra-filtration (UF) system to treat the dilute FP rinsewater. Essentially, UF employs a cluster of tight filters through which the FP rinsewater is passed. The permeate (water that has passed through the filters) is diverted to the company's on-site industrial wastewater treatment facility for further treatment to remove any remaining solids or dissolved metals. The treated wastewater then is reused in plant operations or discharged to the Farmington River. The filtrate - FP concentrate collected by the filters - is transferred to a holding tank. Prior to installing the ozonator, the filtrate had been shipped off-site for disposal. The UF treatment system is 96 percent effective, annually decreasing some 3 million pounds of dilute FP rinsewater to about 120,000 pounds of filtrate. Nonetheless, that remaining FP concentrate - a regulated but non-hazardous waste - still racked up yearly disposal-related costs of about $40,000.

"We use a fairly sophisticated charge-back system that tracks each waste and allocates its costs to the specific department that generates it," noted LaFleur. "The system showed there was an opportunity to further reduce waste from this process and there was a cost-avoidance incentive to do it."

A Pollution Prevention Team (PPT) of representatives from Hamilton Sundstrand's wastewater treatment operations and the three operations using the FP process was chartered late in 1996. After evaluating several technologies, the group selected ozone treatment because it had the greatest potential to eliminate FP concentrate at a comparatively low cost, LaFleur said.

Ozone, a form of oxygen having three atoms to the molecule (O_3), is a powerful oxidizing agent commonly used for bleaching and for disinfecting water, LaFleur explained. Naturally occurring in minute quantities in the atmosphere, particularly after thunderstorms, it can be generated artificially by passing air through an electrically charged chamber. The weak bond between the oxygen atoms in the ozone molecule makes it sparingly soluble in water and causes it to revert back to single oxygen atoms within five to 20 minutes. Those single oxygen atoms then are available for oxidation.

When injected into FP filtrate, the ozone oxidizes the hydrocarbons to produce carbon dioxide and water, thus completely eliminating the concentrated FP waste.

As simple as the process is, the PPT faced some initial hurdles. To begin with, ozone technology had never been applied to FP waste. So, early in 1997, the PPT began working with the ozonator (ozone generator) manufacturer to perform bench-scale tests. These were conducted to verify the effectiveness of the process and to determine the optimal operating parameters, such as the ratio of ozone to FP concentrate and the contact time required to complete the reaction. Once these were established, and the company received approval from the Connecticut Department of Environmental Protection to implement the system, a few more details remained. For instance, because the ozonator was to be integrated with the UF treatment system, new ozone resistant pump seals were needed to protect that system from the decaying effects of oxidation. Additionally, since ozone is a known carcinogen, the ozonator system was equipped with alarms and an automatic shut-off. After working out all the technical issues, the ozonator was brought on-line in November 1997. "Today, the ozone and UF treatment systems work in concert to effectively treat FP waste," asserted LaFleur. "The ozone system, which is leased at an annual cost of $13,000, pays for itself within three months of operation. In 1998, we realized a net cost savings of $27,000 and eliminated 120,000 pounds of waste. We haven't generated concentrate FP waste in over 18 months, and there's no reason why we ever should."

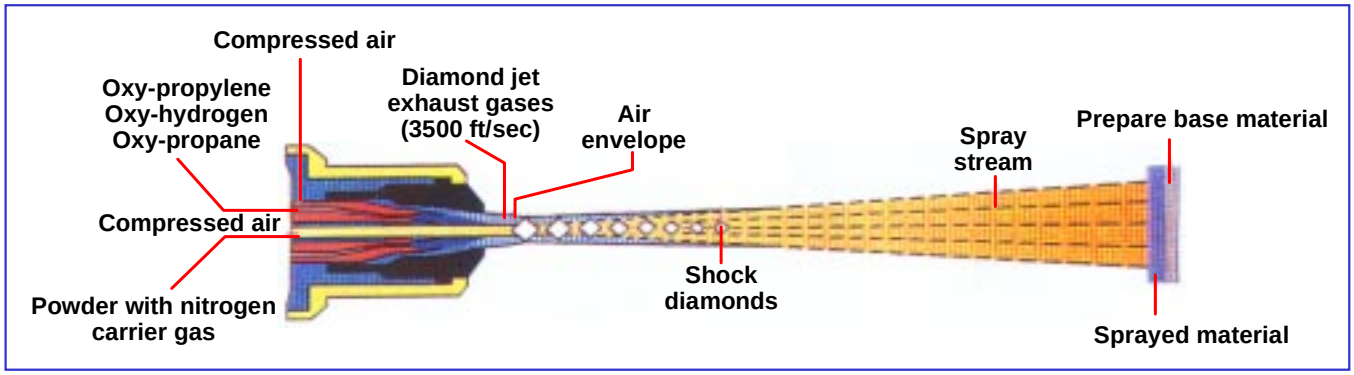
Contact John LaFleur at (860) 654-5376, Technet 433.◆

DOD PARTNERSHIP TO REPLACE HARD CHROME COATINGS WITH HIGH VELOCITY OXYGEN FUEL (HVOF) THERMAL SPRAY COATINGS

The Joint Group on Pollution Prevention (JG-PP) has partnered with the Hard Chrome Alternatives Team (HCAT), a tri-service/industry group, to fully qualify High Velocity Oxygen-Fuel (HVOF) thermal spray coatings to replace hard chrome coatings for specific applications.

The replacement of hard chrome plating with a less hazardous material and/or less regulated process is a high priority within the Department of Defense (DoD). Air emissions and solid wastes from the plating operations are regulated by the Environmental Protection Agency (EPA). The sludge generated from plating tank maintenance and cleaning is disposed of as hazardous waste. Additionally, chrome plating baths contain hexavalent chromium (a known carcinogen) that is strictly regulated by the Occupational Safety and Health Administration (OSHA) through an established permissible exposure limit (PEL) for workers. Previous technology assessments have concluded that HVOF thermal spraying is the best available technology to replace hard chrome on aircraft, ground vehicles, and machine components for line-of-sight applications. It is estimated that between 25-30% of chrome plating cannot be replaced by HVOF and will require additional technology development.

Although HVOF thermal spray systems have been commercially available for over ten years, insertion of this technology into the DoD and weapon system manufacturers has been limited. In 1996, the HCAT began to demonstrate and validate HVOF coatings as a viable replacement for hard chrome on aircraft components. Although the HCAT efforts to date have clearly demonstrated the technical viability of HVOF coatings, full qualification requires the involvement



Representative diagram of a high-velocity oxy-fuel (HVOF) gun and coating deposition showing the oxygen/fuel and powder feed

of all appropriate stakeholders within the military and defense industry. Therefore, to engage stakeholder involvement, JG-PP has partnered with HCAT to execute several projects to qualify HVOF coatings as a replacement for hard chrome coatings in specific applications. JG-PP/HCAT projects are currently underway for landing gear components, hydraulic actuators, propeller hubs, and helicopter dynamic rotor components.

The stakeholder requirements for each project will be established through individual Joint Test Protocols (JTPs), which is a key component of the JG-PP methodology (see web site at http://www.jgpp.com for more details). Potential stakeholders in the qualification process may include repair depot technical representatives and engineering authorities, weapon system program managers or single item managers, and structural engineers from the services and from the original equipment manufacturers. The results of the initial testing by the HCAT (http://www.hcat.org) and other organizations have indicated that the performance of HVOF coatings in terms of fatigue, wear, and corrosion should exceed that of hard chrome, thereby leading to reduced maintenance costs and a reduction in the total-cost-of-ownership for weapon systems.

For more information about these projects, please contact the JG-PP POC, Ms. Debbie Meredith (Air Force Materiel Command), at (937) 257-7505 or Mr. Bruce Sartwell, the HCAT POC (Naval Research Laboratory), at (202) 767-0722.◆

NAVAL AVIATION ENVIRONMENTAL TECHNOLOGY CENTER LEADS TECHNOLOGY NEEDS SURVEY EFFORT

The US Naval Air Systems Command's Lead Maintenance Technology Center, Environment (LMTCE), recently conducted a Naval Aviation-wide survey to determine Environmental, Safety and Occupational Health (ESOH) Technology Needs. The process is very much like the process the Air Force used in their Technology Needs Survey, and now the needs are being submitted directly on-line. The objective of the technology needs survey is to collect, summarize, and communicate technology needs, in an effort to identify environmental, health and safety research requirements to meet those needs.

Needs and/or associated research and development (R&D) projects or associated similar needs were submitted via the World Wide Web at http://aem-lotus.aem-east.com/EnviroView/onlineneeds.nsf. The needs are reviewed, modified if required, and returned to the submitter for final approval. They are then ranked by the NAVAIR Acquisition Environmental Product Support Team, a senior board representing each of the NAVAIR competencies and acquisition programs. Once the needs have been ranked, a more extensive study of commercial off-the-shelf (COTS) or government off-the-shelf (GOTS) solutions or partial solutions and R&D options will be undertaken. The ranked list of needs forms the basis for funding requests to support R&D projects.

The program is a continuation of last year's efforts during which 89 needs were collected and evaluated regarding regulatory and economic drivers and Navy and DoD impact. An in-depth study of 16 needs was also undertaken to identify promising COTS/GOTS and R&D solutions, leading to some of the new R&D project starts.

To date this year, over 40 new needs were submitted. And since there is a mechanism for other organizations to submit a "Me Too" on existing needs, most of the needs are very distinct. The needs represent problems encountered not only at depot organizations but also at intermediate and operational levels, covering both maintenance and facilities issues. These are in the process of review. After the needs have been reviewed they will be ranked early in the first quarter of FY00. Once the needs have been ranked, some will be selected for further analysis and/or identification of promising R&D projects. This process helps to ensure that new research projects are aimed at solving real needs, and that projects such as revising specifications and manuals to allow new process and materials will not be overlooked in favor of more exciting high tech solutions.

For additional information, contact Mr. Gary Whitfield, NADEP Jacksonville, (904) 542-0511, ext. 124, or by e-mail at: Whitfieldgb@navair.navy.mil.◆

ORIGIN AND INCEPTION OF ASC'S P2 VIRTUAL CLASSROOM (VCR) COURSE

Prior to my arrival in March 1995, at ASC/EME Pollution Prevention Branch, direction had already been received (1993) from the Department of Defense to institutionalize pollution prevention into all phases of the acquisition process. At the time (1995) we were under leadership that supported the construction of a P2 course, which had begun in 1994. At that time, the course data was viewed only as a briefing to be given to various entities in the Air Force. With HQ AFMC piloting this ship and being the source of funds, it was decided that the product and operation centers would get this briefing. We would take it to them. When plans for this activity fell into place, the subject became greater than just a briefing but was now called a "roadshow." The contractor completed the research for the Air Force and pulled together some pertinent information on the subject matter that got the attention of the operations/product centers and HQ AFMC. These training and sensitivity efforts that grew out of the original direction were now compiled into the pioneering efforts of the roadshow. This was a phenomenal undertaking because it required teamwork from all those involved. Roadshows with the thumb print of HQ AFMC on them were accomplished in 1996 and 1997 by an ASC/EME representative and the contractor. The targeted audience was operations and product center personnel, specifically all the disciplines that were involved in the acquisition process. Finally the roadshow had accomplished its objective of sensitizing the work force and was about to give birth to a new process called the Virtual Classroom.

Course Conversion and Content

The conversion of the roadshow data to a computer classroom would save thousands of dollars in travel and contractor fees. Accomplishing this task would allow each acquisition person and, in some cases, non-acquisition people, to be

exposed to the Pollution Prevention institutionalization course material via their desktop computers. The benefits of this course are to economically expose more people to Pollution Prevention institutionalization activity in greater and more current detail. This conversion process was completed in August 1999. Course content consists of 14 modules or lessons, each with learning objectives and desired learning outcomes.

- Module 1 is an Introduction to Weapon System Pollution Prevention wherein each student is to understand the importance of the weapon system pollution prevention program.
- Module 2 discusses pollution prevention in the weapon system life cycle.
- Module 3 highlights environmental policy drivers.
- Module 4 expounds on the National Environmental Policy Act (NEPA).
- Module 5 provides insight into the hazardous material policy.
- Module 6 gives a status of ozone depleting substances within the Air Force.
- Module 7 presents a view of pollution prevention and the systems engineering process.
- Module 8 helps the student to see how to integrate pollution prevention initiatives into the acquisition process before milestone 0.
- Module 9 shows integrating pollution prevention initiatives into the concept exploration phase of acquisition.
- Module 10 works with the integration of pollution prevention initiatives into the program definition and risk reduction phase.
- Module 11 talks about the integration of pollution prevention initiatives into acquisition phase II (Engineering and Manufacturing Development).
- Module 12 explains the pollution prevention integration activity into the acquisition system process along with some of the tools that make this happen.
- Module 13 asks the students to apply all available resources to help implement weapon system pollution prevention, while including all other related activities, into the implementation process. It requests that students be able to identify the mission and responsibility of other centers such as Laboratories, Air Logistic Centers, Product Centers, Test, and Disposal Centers as weapon system pollution prevention is implemented.
- Module 14 reflects on capturing lessons learned, immediate concerns, and issues that come out of the institutionalization of weapon system pollution prevention into the acquisition process.

Components of the P2 Virtual Classroom Course

Substantial Across-the-Country Input and Institutionalization of Pollution Prevention

The AFMC-led Center Working Group was the action agent that allowed input from most of the Air Force Centers throughout the US to ensure the construction of this virtual classroom (VCR) course was a good representation of collective thought processes. The dissemination of the draft course content went beyond the Air Force to other services and to government support contractors. Those with meaningful inputs were viewed as significant players in the course construction process. The activity and visibility this VCR course has manifested significantly supports institutionalization of pollution prevention into the acquisition process. It makes those exposed to its content sensitive to the tasking. Evidence of this is being reflected in weapon system acquisition documents. Institutionalization of pollution prevention has not reached perfection because there are still some pockets that are not sensitized yet. However, the VCR course is helping to eliminate that fact.

Availability and Audience

It is anticipated that the VCR course will be offered eight times per year. The audience will be acquisition people that support weapon systems, such as representatives from Labs, Test, Logistics, Product, and Disposal Centers, other services, and government support contractors.

Acquisition Credit and Course Upgrading

Each acquisition person that has a requirement to accomplish a specified number of training hours per year will receive 40 hours of acquisition credit for the completion of this course within the time window provided. This is an important activity because student comments are needed to update, upgrade, modify, and/or add to the VCR course.

Duration of VCR Course Availability and Advertisement/Marketing

Currently the course duration is planned through 2003. During that Fiscal Year, the course will be reviewed by AFMC, ASC/ENVV and SAS to establish its continued worth to the acquisition process. AFMC will decide its fate. The Virtual Classroom course will be advertised and marketed through the AFMC Homepage Acquisition courses, ASC/ENV web site, other Air Force web sites, students that take the course, the Systems Acquisition School at Brooks Air Force Base, the center Working Group, the Pollution Prevention Symposium, the Sys 400 Class at AFIT, support contractors, and the MONITOR.

Conclusion

From the perspective of a subjective taxpayer, I feel this course offers us our money's worth.

For further information regarding ASC's P2 VCR Course, please contact Mr. Charles L. Jones at DSN 785-3059, ext. 311.◆

P2 FOR EGLIN AIR FORCE BASE FIREFIGHTING TRAINING IS A WIN/WIN SITUATION

As a part of an Air Force-wide program, the Eglin Air Force Base (AFB) Fire Department is changing the fuel used for firefighter training from JP-8 to liquid propane to simultaneously achieve two objectives – better/safer firefighter training and reduced impact on the environment. Eighteen AF facilities (of the planned total of 70) have already switched to propane. The program shows how process improvements can also reduce environmental impacts – especially when the improvement addresses a root cause of the emissions.

Firefighting Training Before Change Showing Smoke

Firefighting Training After Change Showing No Smoke

Switching from JP-8 to Liquid Propane Significantly Reduced Smoke Emitted During Firefighting Training as Shown During a Pretest Last Winter at Eglin AFB

The Eglin AFB Fire Department (96 CEG/CEFE) provides training required by Air Force Instructions for approximately 220 firefighting personnel on base. The demand for training is high because of the number of organizations (including other Air Force bases and local governments) that send firefighters to be trained. To accomplish this volume of training, exercises are conducted three to four weekends each month by setting fires under controlled conditions, according to Thomas Ryan, Assistant Fire Chief.

However, using JP-8 as fuel has had a significant impact on the environment. The CY97 Air Emission Survey for Eglin showed that the emissions generated by Firefighter Training in CY97 were 19.4 tons of CO, 18.5 tons of particulate (PM10), 4.7 tons of volatile organic compounds (VOCs), and 0.28 tons of NOx. These emissions were 18% of the total CO emissions and 12% of the total PM10 emissions for Eglin in CY97. In addition, the nearby groundwater and soil have become contaminated by uncombusted components of JP-8 that were spread by firewater.

One root cause for the quantity of annual emissions (the number of fires ignited each year) had already been addressed by minimizing the number of firefighters that needed to be trained and maximizing the number of firefighters trained per session. The number of firefighters trained per fire could not be increased further because personal safety might have been compromised and/or the effectiveness of the training would have been decreased.

Substituting propane for JP-8 addresses another root cause for the annual emissions – the chemistry of the combustion reaction. Based on the emission factors for JP-8 and liquid propane for each criteria air pollutant, the emissions of CO, PM10 and VOCs from Firefighter Training will be reduced by at least 93% (i.e., almost eliminated) when the substitution is made by early summer in 2000. (The emissions of NOx will increase slightly but this training is a minor source of NOx emissions at Eglin.)

Thus, this project simultaneously addresses process improvement and emissions reduction. Not only will the impact on the atmosphere, soil and groundwater be significantly reduced, the firefighter training will also be safer and better. The training will be safer because the trainers – not the trainees – will have control over the fire by turning down the fire when proper techniques are used or by immediately closing the valves if a dangerous situation develops. The change will also provide more effective training because the number and location of ignited propane nozzles can be adjusted to create various firefighter-training conditions more precisely. ◆

THE PROCESS AND POTENTIAL ALTERNATIVES (PAPA) DATABASE

The PAPA database, maintained by PRO-ACT for the Air Force Center for Environmental Excellence (AFCEE), provides Air Force Single Managers and their staffs with a tool to assist them in meeting their responsibility to reduce weapon system dependency on hazardous materials under the Hazardous Materials Reduction Prioritization Process (HMRPP) outlined in Air Force Instruction (AFI) 32-7086. The database provides "leads" on process changes and material substitutions that have been tested, approved, or used by the DoD, other government agencies, and private industry, and which offer a less hazardous alternative to products or processes currently in use. PRO-ACT also works with the AF Weapon System Pollution Prevention Center Working Group to gather information on pollution prevention successes, and shares this information via the PAPA database to AF acquisition and depot-level environmental program managers who are responsible for developing and maintaining weapon system technical guidance.

The PAPA database was originally developed as a Microsoft Excel spreadsheet by HQ AFMC/ENBE. The spreadsheet was turned over to AFCEE/PRO-ACT in 1996 to maintain and distribute to authorized users approved by HQ AFMC. The spreadsheet was converted by PRO-ACT to a Microsoft Access database that is searchable by weapon system category and maintenance process. Updates are distributed each calendar quarter to authorized users.

The PAPA database continues to undergo transformation, and is currently being redesigned to reside on the World Wide Web. The goal of AFCEE/PRO-ACT is to have the web version of PAPA available by Fall 1999. The look of the database will be new, and searches for alternative information will be guided by pull-down menus and interactive exchanges between the user and the program. The web version will provide users with real-time access and the latest information available to PRO-ACT. To this end, PRO-ACT has placed even greater emphasis on obtaining information on alternatives from the weapon system community. The quarterly updates on disk will continue to be available to authorized users who request them.

Pollution prevention successes are being realized throughout the Air Force every day. Evaluating products and process changes as pollution prevention alternatives requires a focused, structured effort over time. It includes a comprehensive examination of an alternative in reducing the overall compliance burden, as well as an assessment of materials compatibility, the ability to meet performance specifications, and the costs associated with implementation. A pollution prevention success is also knowing, through examination and testing, why a product or process cannot be used. This information is just as valuable, and also needs to be communicated Air Force-wide. The PAPA database represents a way to communicate that information in "real-time."

The weapon system community is asked to provide information to PRO-ACT on alternative products or new technologies that have been developed, tested, or are being used. For comments or questions concerning the PAPA database, and to provide information for inclusion into the database, please contact Ms. Barbara Williams or Dr. Christopher Taylor at DSN 240-4240, or e-mail them at pro-act@hqafcee.brooks.af.mil.◆

AIR FORCE SPECIAL OPERATIONS COMMAND (AFSOC)

Air Force Special Operations Command (AFSOC), with headquarters at Hurlburt Field, is the Air Force component of U.S. Special Operations Command. The command provides Air Force special operation forces to conduct unconventional warfare, direct action, special reconnaissance, counter-proliferation, foreign internal defense, information and psychological operations, personnel recovery and counter-terrorism operations.

At Headquarters AFSOC, MSgt Jamieson (AFSOC/LGMWF) brings the maintainer's perspective to the command's environmental decision-making process. HQ AFSOC/LGMW is responsible for all the maintenance issues associated with fixed and rotary wings and equipment. Structural maintenance, which is a key area for corrosion prevention, falls under HQ AFSOC/LGMW's jurisdiction. As such, MSgt Jamieson's participation in the environmental decision-making process ensures that the warfighter's needs are enhanced and not detracted by environmental considerations.

Over the last twenty years, MSgt Jamieson has seen a shift in the maintainer's perspective regarding environmental issues. The maintainer community culture has adopted as second nature the mindset of "doing the right thing environmentally." Today the challenge that the environmental community faces, with respect to the maintainers, is the acceptance of "environmentally friendly products" that are AF/SPO-approved. This cultural change is evolving but is limited primarily from the lack of approved "green" products.

The use of cadmium on weapon system equipment has had downstream environmental consequences at C-130 installations. For example, the use of cadmium on engine parts results in the presence of this material in engine wash water. The use of cadmium on wheels/bolts results in the presence of this material on rags. From the weapon system perspective, addressing or eliminating cadmium early in the design phase or during modifications would simplify future burdens placed on the maintainer.

Other challenges facing AFSOC include developing maintenance procedures that effectively communicate contingency plans in the case of a failure (e.g., hydraulic line rupture) when weapon systems are deployed in locations throughout the world. Environmental reporting requirements under such conditions can vary from location to location. Some of AFSOC's environmental success stories are summarized below.

Success Stories

Empty Container Recycling Program: For the last two years, the eight squadrons which represent the largest Logistics Group in the Air Force have established a mandatory recycling program for empty containers. All cans (including aerosol cans) are drained and recycled. Since 1998, the command has diverted 3600 pounds of cans from entering landfills.

Plastic Media Blasting (PMB) Recycling: Structural Maintenance Element of the 16th Equipment Maintenance Squadron uses plastic media blasting (PMB) to strip various aircraft parts, such as panels, wheels and struts, as well as AGE Equipment. In 1997, the 16th Logistics Group established a contract to recycle the spent PMB generated at Hurlburt Field. This initiative eliminated 5,000-10,000 pounds per year from the blast waste stream.


Gun Parts Washer

Gun Washer: In 1996, the 16th Logistics Group installed an aqueous parts washer in the Weapon System Maintenance flight to simplify the gun cleaning process and enhance worker safety. Before this process change, the maintainers manually washed the gun using a toxic solvent, PD-680. The new process uses soap and water for periodic gun cleaning, requires less labor, and eliminated the use of PD-680 solvent. The wastewater is filtered, allowing the water to be processed through the sanitary sewer system and recycled. The 16th Logistics Group has installed similar aqueous parts washers in the wheel and tire, hydraulic, and jet engine intermediate maintenance shops.

Since 1996, the 16th Logistics Group has established many other pollution prevention initiatives, including a solvent distiller and recovery unit, reusable absorbent pads and wringers, and anti-freeze recyclers.

For additional information regarding these success stories, please contact MSgt Starnick or MSgt Patterson at DSN 579-7373. For additional information about the command's Pollution Prevention program, please contact MSgt Nancy Jamieson, HQ AFSOC/LGMW, at DSN 579-2092 or Capt Monte Harner, HQ AFSOC/CEV, at DSN 579-5984.◆

EPA AND ENVIROSMART PRODUCTS COMPANY SIGN AGREEMENT TO DEVELOP SAFER DETERGENTS AND CLEANERS

EPA signed a memorandum of understanding (MOU) with EnviroSmart Products Company, Chicago, IL, to promote a laundry detergent for light institutional and household uses that minimizes environmental impacts. Under this MOU, EPA will provide technical advice and support to achieve continuous improvement in EnviroSmart's "Ultra LLD" detergent product. EnviroSmart has agreed to formulate the product with cleaning agents that quickly biodegrade into non-polluting byproducts. Ultra LLD contains a mild, biodegradable solvent and fabric softener and ingredients that do not deplete the oxygen of surface waters. Under the formulator right-to-know provision, EnviroSmart will seek test data from its chemical suppliers and encourage them to test when data is lacking. The voluntary agreement was established under EPA's Design for the Environment (DFE) program.◆

ESH TOOLS FOR THE COST COMMUNITY

After a successful effort to make the Acquisition and FM communities aware of the environmental, safety, and health (ESH) issues and concerns via the AFMC ESH Cost Analysis Guide, a follow-on effort has been ongoing to provide the cost analysts with the tools to perform ESH cost estimates. Electronic Systems Center (ESC) at Hanscom AFB has developed ESH-enhanced work breakdown structure (WBS) dictionaries for major Air Force weapon systems. Since cost analysts use the MIL-HDBK-881 WBSs as the basis for their program cost estimate WBS, ESC felt that enhanced WBS dictionaries will help serve as checklists for cost analysts to ensure that ESH activities are included in their estimates. ESC/BP, as the lead organization for this effort, took the MIL-HDBK-881 WBS dictionaries and not only enhanced them with ESH definitions at each appropriate WBS element but also expanded the WBSs to represent a life cycle WBS - from Concept Exploration through Demilitarization and Disposal.

ESC/BP started with the Electronics/Automated Software WBS dictionary which is included in the ESH Cost Analysis Guide, and has since completed the ESH-enhanced WBS dictionaries for Aircraft, Missile, Space, and Ordnance. These four dictionaries, along with the Electronics/Automated Software dictionary, can be found as attachments to the ESH Cost Analysis Guide, which can be viewed and downloaded from www.c2cost.com (under "Reference" then "HAZMAT"). They also have been incorporated into the Automated Cost Estimating Integrated Tool (ACEIT) database. ACEIT is a powerful toolbox developed by and for analysts, and consists of several integrated analysis tools. It helps analysts store, retrieve, and analyze data; build cost models; analyze risk; time phase budgets; and document cost estimates. As of May 1999, ACEIT is installed at over 380 sites within government and industry, and over 3,000 students have completed various ACEIT training classes. Cost analysts can go into ACEIT, retrieve the appropriate WBS for their program, and all the ESH definitions are already in the database. As a part of the ESH Cost Analyst Guide, examples of ESH estimates and trade studies were performed. These examples were also incorporated into the ACEIT Cost Estimating Relationship (CER) library for easy access by cost analysts to use.

For more information on the integration of the ESH WBSs and examples, contact Margy Roeck, ESC/FM, at Margaret.Roeck@Hanscom.af.mil or Peter Logan, ESC/BP, at Peter.Logan@Hanscom.af.mil.◆

UPDATE: ANNUAL SOLVENT CONFERENCE

The focus of the annual solvents conference was on alternatives to solvents in cleaning and painting operations. There was notable DoD involvement, including briefings by Assistant Deputy Under Secretary of Defense (Environmental Quality), Army, Navy and Air Force, as well as booths by the Joint Group on Pollution Prevention (JG-PP) and the Strategic Environmental Research and Development Program (SERDP). The Environmental Protection Agency (EPA) presented several papers on topics such as the Coating Alternatives Guide (CAGE), Green Products Database and status of standards development. Vendors of solvent alternatives provided information at booths and gave presentations during some of the sessions. Several interesting alternatives were discussed, including a new water-based CARC developed via a SERDP project; PCBTF, which is a new VOC-exempt paint thinner and paint

gun cleaner; Pyrocol, a Halon replacement chemical for fire suppression; and Dryview, which replaces chemicals in photo developing. A cleaner by Abzol [contact 800-535-3030] with properties very similar to trichloroethane (TCA) can be used in vapor degreasers [Note: This may be a solution to the problem of a vapor degreaser with trichloroethylene (TCE) being transferred from SM-ALC to OO-ALC.]. Once more information is collected from the vendor of Abzol, information on these alternatives will be given to PRO-ACT for possible inclusion into the Process and Potential Alternatives (PAPA) database.

Solvent testing efforts that were discussed included the EPA's Green Chemistry Program, the Army's joint-funded alternative cleaner performance validation program, JG-PP projects with test protocols, and the Green Seal test efforts. The EPA has information on alternatives from their Green Chemistry Program on the Internet at http://www.epa.gov/opptintr/greenchemistry/index.htm, in addition to the Solvent Alternatives Guide (SAGE, available at http://clean.rti.org) and CAGE (available at http://cage.rti.org) systems.

The return of vapor degreasers was discussed. A new manufacturing process for lactate esters is resulting in lower costs, which should allow a broader use of this alternate substance. Advancement in new polymers has allowed development of improved water-based CARC paint.

Although the conference seems to have fewer sessions than in prior years, it is still a very informative technical conference on solvent alternatives.

For more information, please contact Carroll B. Herring, HQ AFMC/ENBA, at (937) 257-6448.◆

A NESHAP-COMPLIANT PAINT GUN CLEANING EQUIPMENT TRANSITIONED TO WR-ALC UNDER THE TRIAD PROJECT

In concert with the C-130 Directorate (WR-ALC/LB), the Pollution Prevention Branch at Robins AFB (WR-ALC/EMPP) has prototyped, and is using, a paint gun cleaning system that complies with the Aerospace National Emissions Standard for Hazardous Air Pollutant (NESHAP). Based on the successful demonstration/validation of this technology, WR-ALC is installing an additional five units to support daily operations for F-15, C-5, C-141, and JSTARS aircraft and the Technology and Industrial Support Directorate. Other installations and facilities can potentially benefit from this technology.

The transition of this technology from initial assessment to final implementation and use was completed in approximately 18 months. According to Dave Bury, WR-ALC/EMPP, the Toxic Release Inventory Alternative Development (TRIAD) process provided the framework and resources to ensure that customer needs were identified and addressed in a cost-effective, timely manner. The TRIAD Project, developed by WR-ALC/EMPP, identifies and evaluates industrial process areas that (1) are regulated under NESHAP; and/or (2) use Toxic Release Inventory (TRI) listed chemicals; and/or (3) use ozone-depleting substances.

The key factors contributing to the successful implementation of this technology are summarized below.

Background

Historically, WR-ALC paint facility personnel have used methyl ethyl ketone (MEK), toluene, and polyurethane thinner, MIL-T-81772, as solvents for spray gun cleaning. These solvents and their constituents are classified as hazardous air pollutants (HAPs) and are listed on the TRI. Requirements under NESHAP for aerospace manufacturing and rework facilities regulate cleaning operations.

Under TRIAD, WR-ALC/EMPP initially completed the Spray Gun Cleaning Process and Evaluation (PAE) Report (see Figure 11). The report recommended implementing an integrated gun washer/solvent reclaimer system. This type of system is most effective when large volumes of solvents are used for gun washing. Based on available technology, the PAE Report recommended the Becca USA Spray Gun Washer/Solvent Reclaimer System for WR-ALC.

The Becca USA unit is NESHAP-compliant, reduces solvent use, and has design preferences identified by WR-ALC weapon system directorate personnel (see Figure 12). The system provides a paint gun cleaning work area with reduced solvent exposure, eliminates handling of solvent, and reduces the overall volume of solvent used via recycling. The unit also provides added flexibility by allowing workers to simultaneously wash two guns automatically, manually disassemble and clean guns, and recycle solvent.

Technology Demonstration/Validation

According to Dave Bury, the successful demonstration/validation of the Becca USA Spray Gun Washer/Recycler System resulted from the synergy between the TRIAD Process, the MEEP Program, and the equipment manufacturer.

- The **baseline section** of the report describes the current aircraft directorates' paint shop practices, provides information on spray gun cleaning equipment and discusses solvents currently used by the WR-ALC aircraft directorates. The baseline section also includes chemical, regulatory, fire, safety, exposure, and current chemical cost data.
- The **process requirements section** of the report discusses the Aerospace NESHAP regulations as they pertain to spray gun cleaning. This section details the specific regulations and the alternative techniques that can be used to meet compliance requirements. A listing of the WR-ALC Corrosion Control Facility personnel's general performance requirements and preferred features is also provided.
- The **alternative process evaluation section** discusses the methods and equipment identified as compliant with the Aerospace NESHAP regulation and the WR-ALC requirements. Three types of equipment are presented in this section: **1) integrated gun washer/solvent reclaimer systems, 2) gun washer units, and 3) solvent reclaimers**. Vendor models, costs, and specific product features and specifications are also provided. Detailed vendor product information is presented in the referenced appendices. This data provides the basis for recommendations and conclusions for the selection of compliant spray gun cleaning equipment.
- The **final section** of the report provides recommendations for spray gun cleaning systems according to the type of paint facility and work volume. The units recommended will most effectively fit the directorates' needs, meet Aerospace NESHAP compliance regulations, and most closely match features preferred by facility personnel.

Figure 11. Contents of the TRIAD PAE Report

The TRIAD Process was critical in ensuring early buy-in from all potential stakeholders. As part of the PAE Report, WR-ALC paint shop personnel were interviewed regarding preferred equipment design features and general performance requirements. These specifications (see Figure 12) were a critical factor in the selection of the Becca USA unit. The MEEP Program gave WR-ALC the flexibility to acquire, but not purchase, the desired equipment prior to full-scale demonstration/validation. Becca USA worked closely with WR-ALC personnel and modified equipment, as needed, in a timely manner to satisfy all functional and regulatory concerns identified during equipment demonstration.

- Ease of operation
- Ability to simultaneously clean siphon-fed/pressure-fed HVLP spray guns
- Ability to manually clean paint guns and cups - provide workspace for gun disassembly
- Automatic paint gun washing
- Capability for solvent recovery
- Low maintenance requirements
- Vacuum venting of emissions

Figure 12. Preferred Features Requested by Paint Shop Personnel

In July 1999, representatives of Becca USA completed the final installation of the unit and provided the necessary training for operating the system to facility supervisors and designated painters. During training, paint guns and cups used to spray epoxy primer MIL-P-23377, polyurethane topcoat MIL-C-85258, and PR-1432 coatings were successfully cleaned in the Becca washer using the MIL-T-81722 thinner.

For further information regarding this success story or the TRIAD Process, please contact Mr. Dave Bury at DSN 468-1197 ext. 140. Development information can be found on the WR-ALC/EM web page, http://www.em.robins.af.mil. Refer to the site map for the path to TRIAD. You will need Adobe Acrobat Reader software, which can be downloaded for free.◆

ACHIEVING COMPLIANCE THROUGH POLLUTION PREVENTION: SUCCESS STORIES FROM EDWARDS AIR FORCE BASE

MEK Substitute for F-16 Aircraft Maintenance Activities

The 412th Test Squadron at Edwards AFB previously used methyl ethyl ketone (MEK) for their F-16 aircraft maintenance operations.

Under the applicability determination requirements for compliance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP), Edwards AFB is defined as a major source of hazardous air pollutants (HAPs) and must comply with the Aerospace NESHAP (40 CFR Part 63 Subpart GG). Using MEK solvent for aircraft specific applications would result in non-compliance with the Aerospace NESHAP.

Acetone, a product of a less hazardous nature, was substituted for the MEK. The use of acetone for this particular aircraft maintenance application is in compliance with the Aerospace NESHAP and thus eliminated a non-compliance concern.

Green Waste Composting

With the passage of California regulation AB 939, the permitted Class III landfill at Edwards AFB must comply with a 50 percent reduction in solid waste by the year 2000.

Large quantities of green waste are generated from yard work and landscaping projects. In the past, green waste was transported to the Edwards AFB main base landfill. Due to the large amount of green waste requiring disposal, Edwards AFB paid contractors to haul the waste off base in order to comply with AB 939 and to extend the life of the landfill. The nearest available off-base landfill is 24 miles away in Mojave, CA. Travel time to the landfill is approximately 30 minutes, with 30 to 45 minutes to offload and another 30 minutes to return to the base. The trucking cost for hauling municipal solid waste, fully burdened, is approximately $75/hr. Tipping fees are currently $30.45/ton. Each truck has a capacity of 35 cubic yards and can transport 6.2 tons per load.

Edwards AFB has established a comprehensive composting operation for processing green waste at the main base landfill. In 1998, 2,240 tons of green waste were diverted from disposal at an off-base landfill; this diversion saved the Air Force $109,022 in disposal costs. The compost material is used on base for landscaping and soil amendment. This process also applies to affirmative procurement for the reutilization of composting material. Additionally, the compost program is expected to extend the life of the landfill by approximately 3.5 years.

Chlorine Gas Substitute

Prior to 1999, the 95th Civil Engineer Squadron (95 CES/CEOUWH) used chlorine gas (disinfectant) with sodium bicarbonate (clearing agent) to chlorinate two outdoor pools. In 1998, $2,321 was spent on chlorine and $5,393 was spent on sodium bicarbonate.

Chlorine gas is documented as one of the ten most hazardous chemicals used at the installation, so its use at the pools must be documented in the base's Risk Management Plan (RMP). The cost for additional inspection of the compliance sites, assessment report, and updating the RMP is estimated at $500.

In 1999, the chlorinating process was changed to a process involving placing chlorine tablets in a feeder-unit in line with the pool piping. This "automatic chlorine feeder" eliminates the need for the chlorine gas cylinders. When these cylinders are removed, two compliance sites and the need to incorporate them into the RMP will be eliminated. The elimination of the gas leak hazard will improve safety for maintenance personnel and pool users. In addition, the chlorine tablets contains a clearing agent, which reduces the amount of sodium bicarbonate needed. Three automatic chlorine feeders ($418), chlorine tablets for five months ($2,919) and sodium bicarbonate ($431) were purchased for a total cost of $4,366. The new process saved the Air Force $3,348 over five months, resulting in a payback period of about 1.3 years based on the short pool session.

For more information on these success stories at Edwards AFB, please contact Ms. Mary Spencer at DSN 527-1466.◆

Upcoming Events

Date	Conference	Location	POC - Phone/Fax/E-mail/Website
30 Nov - 2 Dec 99	1999 Partners in Environmental Technology Technical Symposium & Workshop	Hyatt Regency Crystal City Arlington, VA	Ms. Jenny Rusk Phone (703) 736-4548 jrusk@hgl.com www.serdp.org www.estcp.org www.serdp.org/symposiums/1999/announcements
4-9 Dec 99	4th Annual Joint Services Pollution Prevention/Hazardous Waste Management Conference and Exhibition	Henry B. Gonzalez Convention Center San Antonio, TX	Ms. Christy Kline Phone: (703) 247-2587 ckline@ndia.org
12-15 Dec 99	U.S. Environmental Laws and Regulations	Williamsburg, VA	Phone: (310) 921-2345 (310) 921-0264 www.govinst.com
8-10 Feb 00	Center Working Group (CWG)	Kennedy Space Center	Lori Luburgh DSN: 787-7352 www.afmc-mil.wpafb.af.mil/CWG
12-15 Feb 00	Fundamentals of New Source Review	Denver, CO	Phone: (412) 232-3444 FAX: (412) 232-3450 www.awma.org
18-22 Jun 00	Air and Waste Management Association's 93rd Annual Meeting and Exposition	Salt Lake City, UT	Phone: (412) 232-3444 FAX: (412) 232-3450 www.awma.org